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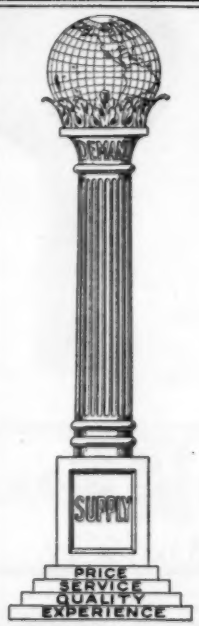

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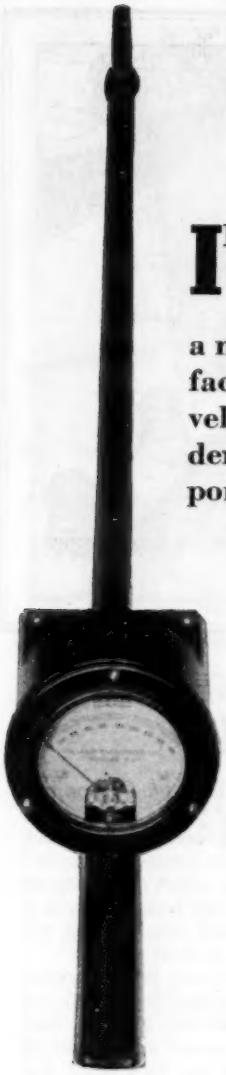

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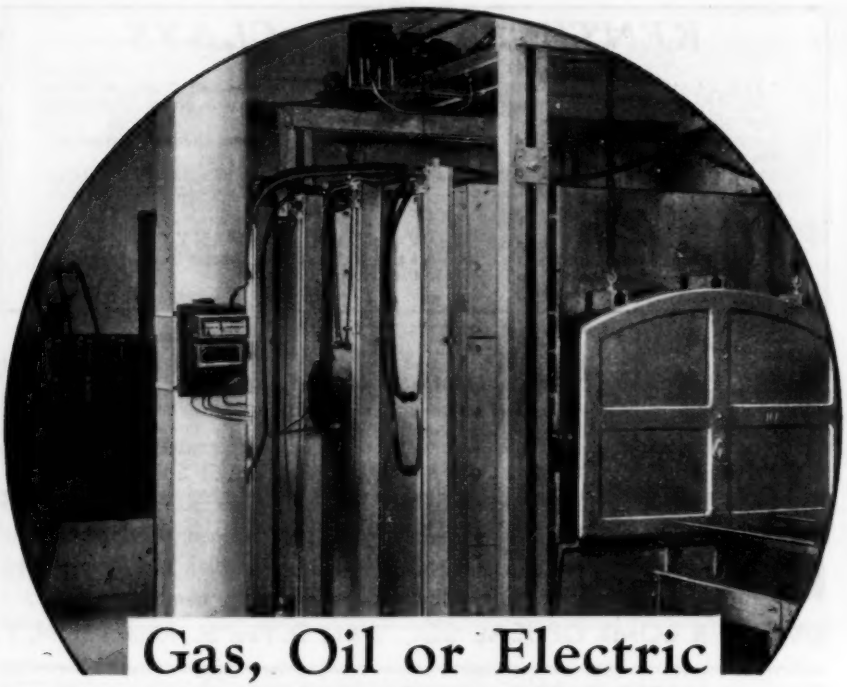

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STIFF-MUD DIE TROUBLES[1]

By Ellis Lovejoy and H. B. Henderson

ABSTRACT

This paper illustrates faulty and cracked ware in consequence of improperly adjusted dies for stiff-mud products.

Introduction

The proper adjustment of stiff-mud machine dies to correct the faults in the ware which occasion serious losses in the drying and firing has not been worked out. The troubles are often erroneously charged to the drier or to inherent faultiness in the clay. Laminations are prevalent and likely ever will be, but there is an opportunity to reduce such faults greatly by die adjustments to get a maximum degree of uniformity of flow of the clay through the die, and by chemical treatment to coagulate the clay. The latter is outside of the present consideration.

Laminations

Case No. 1 Figure 1 shows end-cut brick from a very faulty clay, dried in 24 hours, 72 hours, and seven days, respectively. The brick on the right, dried rapidly, shows a central core commonly designated as "auger" lamination. The outer shell is broken from end to end on each of the four faces and has fallen away from the core. The cracks are limited to the four straight cracks through the faces and the latter shelled off from the core.

The middle brick was dried more slowly, and in it is a circular end crack outlining the auger core, and the shell is cracked in a single crack on each face from end to end.

The slowly dried brick has the circular end crack outlined and there are the long straight cracks on the flat face which do not show plainly in the photograph. Cracks are also developing on the edges. It has a single cross-crack.

Character of Clay Though this clay is very plastic and sticky, yet it is not inherently bad in its drying behavior insofar as the clay itself is concerned. If it could be made without the machine faults, it would be practical to dry ware from this clay though probably not rapidly.

Die Corrections The structural faults cannot be overcome in the die alone, but the flow can be greatly improved by several devices: (1) an extension ring between the die and auger, (2) gratings or spiders back of the die, (3) rounding the back corners of the die, (4) an

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

extension arm on the front end of the auger, either straight or flared, (5) a minimum pitch to the die, (6) perfect lubrication of the die, etc. Such devices together with chemical treatment of the clay and humidity drying, will make this clay a practical material.

Each clay is a problem in itself and in each, the problems must be solved by factory trials.

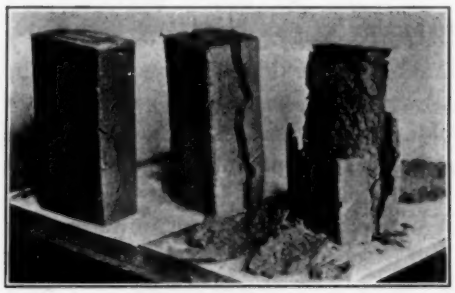

FIG. 1.

Case No. 2 The solid brick on the right of Fig. 2 has a larger auger core than the one in Fig. 1. The straight end-to-end cracks are not strongly in evidence.

The cracking of the middle brick evidently is not closely related to the brick structure. The surfaces are broken up into small angular sections characteristic of inherent bad drying qualities of the clay. Such cracking is often characterized as mud-puddle cracks.

This clay will crack, however free from structural faults the ware may

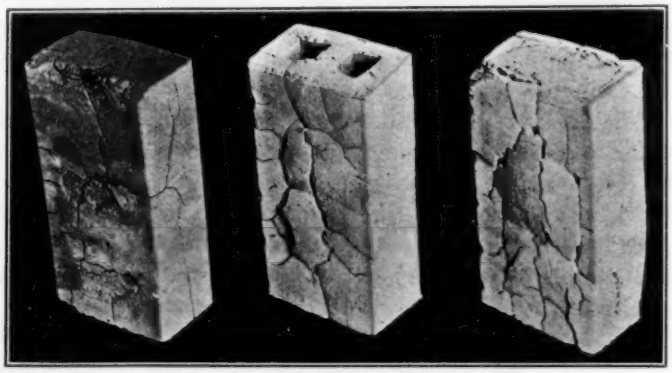

FIG. 2.

be. Such a clay can only be made practical by chemical treatment or by preheating.

Case No. 3 The brick on the left is a type between the other two. It is a sticky clay as may be seen in the serrated corner where the column was torn by the drag in the die. In general it has the end-to-end structural cracks and circular end cracks, but in addition there are cross-cracks, breaking the mass up into small sections.

Case No. 4 Figure 3 shows a four-by-five hollow block with two cells, using two bridges across the die. The clay is a plastic surface clay which has been used for many years in the production of drain tile up to twenty-four inches in size without serious loss in the drying. Though dried slowly, at times the drying conditions were a bit severe.

Every attempt to make rectangular building block from this clay was a failure. The concave ends clearly determined the cause of the trouble. These were attributed to the cutter, though it was reluctantly admitted that both ends could not be concave in consequence of crooked cutting. The trouble was found to be due entirely to lack of proper adjustment of the die.

Clearly the side walls flowed faster than the web. The web was being stretched and even torn as seen in the crescent-shaped cracks in it. The tendency of the side walls was to turn in as they left the die, or a short distance beyond the die. There was a tendency to belly out, to expand into a curved shape.

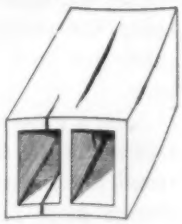

FIG. 3.

The cutting wires in passing through the clay knitted the ends together sufficiently to resist cracking immediately at the ends. In drying, the attenuated web had greater shrinkage than the walls which put it under high-tension strain. This was partly relieved by the wide cracks across the web, partly by the bowing outward of the side, and partly by the shorter length of the web as seen in the concave ends.

It is likely that the top and bottom side walls were flowing more slowly than the other side walls since the bridges would retard such flow of the clay and this would explain the other end cracks, although all of these might go back to the slow movement of the web, since they were close to the web and not a bridge crack, which would be centered on the cell.

Correction The correction of this trouble was apparent. The web should have been made thicker and the side walls thinner or drags should have been put on the back of the die to retard the flow of the side walls.

It might have been necessary to make more refined adjustments by easements under the bridges and by curved extensions of the die surface from the back of the die.

Case No. 5 Figure 4 is a 6- by 12-three-cell hollow tile made from a plastic terrace clay. The ends were convexed. The webs were flowing faster than the edge walls.

In attempting to make adjustments, difficulty developed. Though the die was made to provide for such adjustments in that both the cores

and bridges could be changed in the spacing, yet it developed that no matter how thin the webs were set, when the clay began to flow the posts were sprung outward and the webs remained thick as in the first instance.

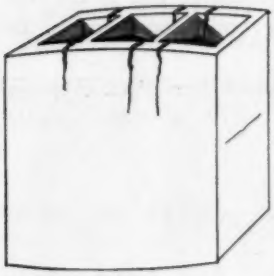

FIG. 4.

Such a die cannot be adjusted, certainly not easily. The back of the die could be eased out for the side walls to provide for easier entry of the clay in this portion of the tile and retarders could be put on the bridges or cores to retard the flow in the webs. Possibly a deflector could have been attached to the auger point. Any change in the viscosity of the clay would have affected the thickness of the webs and the uniformity of the flow of the clay differently.

One die manufacturer attempted to overcome such post weakness by tying the posts together with continuously-threaded rods through the posts just back of the cores, and the posts were held and adjusted by set nuts.

Such a mess of rods in a six-cell tile reduced the output of the machine and made the situation worse. As one of the rods wore through, the die would be opened, the broken part cut out, and operations resumed with one or more posts free to spread. With new dies sufficiently strong to withstand the lateral pressure, the output was increased and the drier loss of 40% or more dropped to a normal few per cent.

Design of Die Bridges

Figure 5 shows the back of a 4- by 5-tile die with two bridges. The cores spread. The bridges were made wide in the direction of the flow of the clay to resist bending and they were made thin to reduce the resistance to the flow of the clay and to make as narrow a cut as possible.

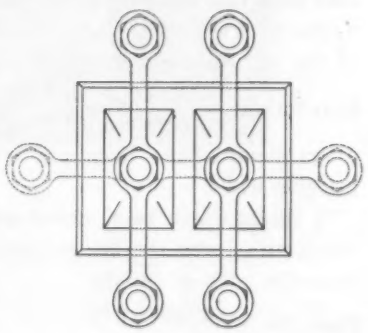

FIG. 5.

Such a shape does not resist torsional bending.

The trouble was corrected by making the bridges as shown by both dotted and solid lines. The dotted line addition to the bridges stiffened the bridges and minimized the torsional strain. An extension to the auger point with a funnel or flaring head would likely have been effective.

Figure 6 is the back of an "S" roofing tile die and a longitudinal sec-

tion of the die. The curves have the same radius top and bottom to nest the tile in drying, firing, shipping, and in laying. Thus the ends and center of the slot are narrow and the centers of the curves are wide. The original die was simply a flat plate with the "S" slot cut in it with some

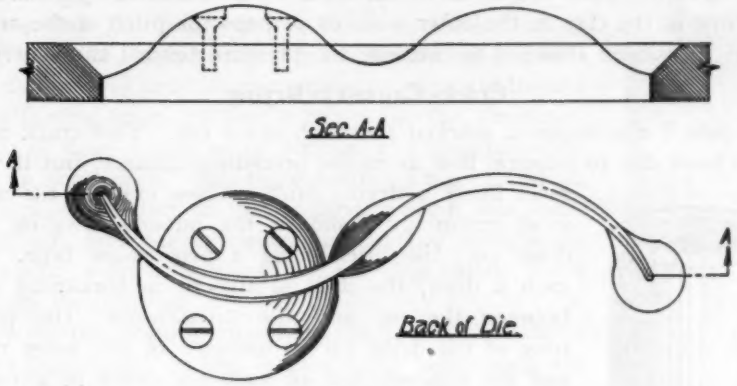

FIG. 6.

pitch. The flow through this die was nonuniform. The column split down the center and the sides were torn into sections scarcely more than six inches long. Then the adjustment of the die began. The ends and center were hollowed out on the back of the die, which improved the flow, but not sufficiently. The die then was built up on the back between the ends and center by curved blocks to lengthen the die surface gradually as the width of the opening increased. The contour of the back of the die is shown in the longitudinal section. With these corrections, the column flowed continuously without a break.

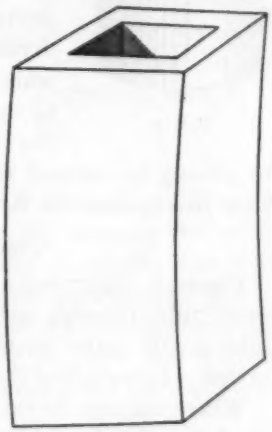

FIG. 7.

It is by such corrections as these that the die may be adjusted to get a uniform flow of clay within the limits required by the clay. Some clays, more particularly shales, require no die correction; it is likely, however, that die adjustment would result in a stronger tile. Other clays require delicate adjustments. The usual method of adjustment is to fasten a flat plate to the back of the die, lipping over the edge. This serves in many instances, but it is not a good method. The die friction surfaces should be shortened and lengthened.

Figure 7 shows a 4- by 5-single cell tile and the product was made through

a two-stream die. In every instance the tile were curved and the concave side was the center wall as the stream flowed.

The clay was flowing fastest in the outer walls and the center walls were being stretched. In drying, the latter had the most shrinkage and the curvature followed. This could have been corrected by retarding the flow of the clay in the outer walls or perhaps the pitch of the auger could have been changed to increase the pressure toward the center.

Cracks Caused in Drying

Figure 8 also shows a cracked four-inch drain tile. This crack may have been due to unequal flow as in the preceding instance, but it was more likely a drying fault. These cracked tile were most commonly found in the outside rows on the drier car, the drier being a progressive type. In such a drier, the drift of the air is horizontal and between the car and the drier walls. The outer rows of tile dried far in advance of the inner rows and the exposed side of each tile dried in advance of the opposite side.

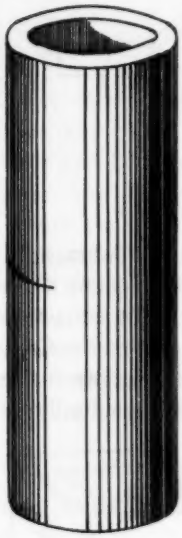

FIG. 8.

In the first stage of the drying, the ends of the tile curved outwardly, then as the opposite side of the tile dried, the tile was straightened but the dry side could not resist the bending strain and frequently cracked. This cracking is a drier trouble and not a die adjustment problem.

Despite the wide use of progressive waste-heat driers, there is none so lacking in uniformity of drying as this type. If they were built with sand seals or some other contrivance (which could easily be done), so that the hot air could come up through the car deck and onward up among the ware, instead of coming up around the car and then drifting through the relatively wide free spaces, tile fairly uniformly dried would be obtained.

Cracking Due to Faulty Tube Die

Figure 9 illustrates a plunger equipment. In attempting to make a small tube through such an equipment, it was demonstrated that the tube simply curled up after leaving the die and no good product was obtained. By rounding the back corners of the die, a good tube was produced.

Where the clay forms its own neck back of the die, there is more likelihood that the clay from the sides will enter more or less vertically into the flowing column and thus have a serious effect on it. Rounding the back corners of the die allows the clay around the side to bend gradually in toward the direction of the flow.

Figure 10 shows two plugs from a die with a portion of the mass of clay in the neck back of the die. There was a square shoulder as was the case in Fig. 9. The neck of one of these plugs cracked loose in drying, thus giving a view of the flow of the clay along the plane of the clay-formed neck. (The figure does not bring out the curve clearly.)

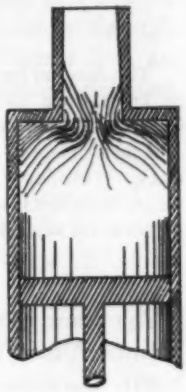

FIG. 9.

The curve starts gently from a horizontal (vertical in the picture) direction and gradually curves in toward the flowing mass. Where it enters the die, the direction of flow of this outer portion was approximately at an angle of 45° into the column. To get a line on the possible effect of this method, a form was made and put into the extension ring of the small auger machine to draw the size of the barrel gradually down to the die opening.

With this form in operation, the flow of the column was improved. In the several tests made with the same sticky clay, the results showed tearing on the corners and furred surfaces without the form; with it these faults in the column were not in evidence. Though a better surface was obtained, the transverse strength in the bar was no higher. This problem is to be studied further to determine the possibilities of such corrections in the equipment back of the die.

FIG. 10.

Conclusion

The dies are very crude. They were made flat on the back with a square shoulder from the extension ring to the die opening; the bridges were bolted to the back of the die, which unequally affects the flow of the clay. Minute adjustments are required for difficult clays to get any product from them, and if a good product can be made from a bad clay, it is hoped to make the good clay products better, stronger, and with less loss if they are given the advantages that are necessary for the poorer clays to get any product at all.

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VAPOR GLAZING AND COLOR FLASHING OF PRE-CAMBRIAN SHALES[1]

By Hilton L. Longenecker

ABSTRACT

The demand for colors in brick was first met by the manufacturers of red face brick by fire-flashing their normally red firing material, producing a range of brown and brownish red colors. Later they used vapor glazing with zinc and color flashing with coal tar. The red face brick color range includes green, mustard, purple, and glossy black. This paper describes the materials, methods, and results obtained at the Seaboard Shale Brick and Tile Company plant at Monroe, N. C., and was checked at other plants in the same district.

Geology of the Clay

The plant in which the work described here was done is located near Monroe, Union County, N. C., which geologically is in the Slate Belt of North Carolina. The Carolina Slate Belt embraces a belt of country varying in width from eight to fifty miles and extends in a general southwesterly direction across the east-central part of the state. Its western boundary is marked by a line drawn a few miles east of the towns, Greensboro, Lexington, and Charlotte, and its eastern boundary by a line a few miles west of Durham, Sanford, and Wadesboro. The belt is widest between Sanford and Lexington, and becomes narrower to the north and south.

The rocks of the area, because of the complex character and well-defined cleavage, have been called "slates," but this name is misleading. They consist of volcanic-sedimentary formations made up of slates and tuffs with which are long interbedded bands and lenses of volcanic breccia, flows, and ash. There are two distinct types of tuffs, breccias, and flows; one is acid and the other more basic. The acid type consists of fine and coarse tuffs, and of breccias chiefly of a rhyolitic and dacitic character, with flows of rhyolite and dacite. In the basic type, the breccia and flow types are more common than are the fine and coarse tuffs, but the latter are usually present at least in small amounts. Diabase dikes doubtless of Triassic Age cut the other formations.

Metamorphism has been so complete that shales have become slates and the tuffs, flows, and breccias, have been so sheared that it is difficult to tell in the field which is slate, tuff, or flow. Hence they have all been called "slates." The series has been mashed and bent into folds and the original bedding planes have been largely destroyed by a well-defined cleavage which dips from 45 to 85° to the northwest. The strike of the cleavage planes, axes of folding, and different formations are all practically parallel and vary from N 65 to N 30°E.

[1] Received June 20, 1930.

In the following table, the first three analyses are of materials from the Carolina Slate Belt, while the fourth is a normal slate from Lancaster County, Pa. The first three analyses show an excess of soda over potash, which indicates that the slate of the Carolina Slate Belt did not go through the normal cycle of weathering as did the clay slate. Numer 5 is an analysis made of the shale or slate used by the Seaboard Shale Brick and Tile Company.

	No. 1	No. 2	No. 3	No. 4	No. 5
SiO_2	66.43	61.02	52.62	60.32	60.57
Al_2O_3	16.27	25.54	33.20	23.10	26.50
TiO_2	0.43		4.04		
Fe_2O_3	4.02				4.05
FeO	0.98	4.46		7.05	
MgO	0.14	0.14	0.27	0.87	0.10
CaO	1.27	0.60	2.52		0.83
Na_2O	5.90	2.19	3.80	0.49	2.10
K_2O	1.76	1.81	0.49	3.83	1.53
H_2O	2.67	4.20		4.08	4.15
P_2O_5	0.07				
CO_2			0.66		
	99.94	99.96	97.60	99.74	99.83

References (1) Typical, banded, dark slate, Wet Creek, Moore County, North Carolina, J. L. Stuckey, analyst.

(2) "Slate" from Haile Mines, S. C. Charles Baskerville, analyst. H. B. C. Nitze and G. B. Hanna, "Gold Deposits of North Carolina," N. C. Geol. Surv., *Bull.*, No. 3, p. 34 (1896).

(3) Typical black slate near Gold Hill, R. T. Allen, analyst. F. B. Laney, "Gold Hill Mining District," N. C. Geol. Surv., *Bull.*, No. 21, p. 28 (1910).

(4) "Roofing Slate," Lancaster County, Pa. G. P. Merrill, Rocks, Rock-Weathering, and Soils, p. 119 (1913).

(5) Analysis Monroe Shale, Charlotte Chemical Laboratories, 1925.

Physical Properties of the Shale

The material has fairly good plasticity and require 28.3% water to become workable by the stiff-mud process. The range of 2.5% variation of water content is rather narrow, but it is maintained by a competent pug-mill operator.

The dry ware is extremely weak, the modulus of rupture being only 111.1 lbs. per sq. in. This weakness makes the dried ware somewhat difficult to handle without chipping. The drying presents no difficulties. The shale will stand rapid high heat drying conditions without loss. The volume drying shrinkage is 6.5% and the linear shrinkage, 2.2%.

The fired linear shrinkage is also low, increasing uniformly from an expansion of 0.7% at cone 07 to a shrinkage of 11.4% at cone 7. The total linear shrinkage at cone 02 is 9%; at cone 7, 13.6%.

The absorption drops rapidly but uniformly from 28% at cone 07 to

1.9 at cone 8 and then rises rapidly showing overfiring caused by the fluxes in the material, principally soda, potash, iron, and lime.

The color at cone 04 is a light red and at cone 2 becomes a dark red. At cone 8, the color becomes a greenish black. The ware is steel hard at cone 01.

Uses of the Shale

This material has been found excellent for the manufacture of both face and building brick. The Carolina Shale Brick Company of Norwood, N. C., is making an excellent face brick in several beautiful textures from this shale. This plant has made structural tile and vitrified brick, the latter for the lining of acid towers.

The Yadkin Brick Company at New London, the Cunningham Brick Company at Thomasville, the Mount Gilead Brick Company at Mount Gilead, and the Seaboard Shale Brick and Tile Company near Monroe, N. C., use this shale in the manufacture of high-grade face brick and common brick. An attempt was made in 1922 at the last-named plant to manufacture radial chimney block. At the plants of both the Seaboard Shale Brick and Tile Company and the Carolina Shale Brick Company, the material has been found to be too short, lacking plasticity to form the webs properly of either structural tile or radial chimney block.

Method of Setting and Firing

Setting The brick are set eight courses high, faced, and the remainder are flat set to a total height of 32 brick. The best setting, to avoid warping, has been found to be flat-set 4 brick high and a four brick tie flat-set. The flat-set brick are heavily sanded with screened sharp sand.

Type of Kiln Used Kilns are round downdraft, 32 feet in diameter. They have ten furnaces each of the dead bottom type, and each of which is twenty inches wide. The flue system is of the hub and spoke design. Stack draft is used.

Water-Smoking Dead bottom furnaces being used in connection with stack draft, the length of the water-smoking period is influenced by the time required to heat the stack. A fire is placed at the back and bottom of each furnace and built upon the furnace slope as rapidly as draft will permit. As there is no carbon to be oxidized out of this shale and no danger of bloating, the furnaces are gradually closed after a period of 24 hours and water-smoking is complete.

After the temperature reaches 800°, it is raised 200° per 24 hours.

To maintain oxidizing conditions in the kiln, the furnaces are not entirely closed at any time. Fires are cleaned and clinkered regularly so that a thin oxidizing fire is the rule at all times. The maximum temperature of 1850°F is reached on the sixth day.

To equalize the heat in the kiln, 1850°F is held for 24 hours, the degree of vitrification of the brick in top and bottom of the kiln being determined by taking a series of draw trials from holes in the kiln doors which correspond with draw-trial tunnels set from door to door of the kiln.

The normal oxidized color of this shale is a deep cherry red.

Vapor Glazing with Zinc

The brick are fired to vitrification, this finishing point being determined by draw trials and pyrometer, the same as if the kiln were being fired for red brick. Up to this point oxidizing conditions are maintained as nearly as can be done by hand firing.

Preparation of Kiln for Vapor Firing Preparatory for zinc vapor glazing, all furnaces are carefully and thoroughly cleaned and clinkered. Following this, a good bed of fire is built back into each furnace, fires being kept slightly tighter than they had been, the idea being to build up the furnace temperature as high as possible. The conditions are reducing. This takes about one hour and is an important part of the operation. At the end of this period each furnace is a bed of white hot coke, has been entirely closed with coal slack, and the bag walls are white hot.

Vapor Glazing Process Four men are required to fire the zinc, one to push coal off the coking plate, one to shovel the zinc, one to push the wheelbarrow, and one to close up the furnaces with slack coal.

If pig zinc is used, the 50-lb. pigs are broken by a sledge into pieces weighing about 3 pounds. These are thrown into the furnaces by hand, 12 to 15 pounds per furnace, and as far back against the bag walls as possible. Scrap zinc is fired with the shovel, and about the same weight is used.

Getting it back against the bag walls is an important point, as there it finds the maximum heat.

The firing of the zinc is done as rapidly as possible. As soon as the last furnace has been fired, the damper is dropped to within about four inches of the bottom of the stack flue. The brick are allowed to soak in the zinc vapor for twenty minutes. At the end of this time, the damper is lifted and the zinc firing is repeated. Three successive firings of zinc are made at 20-minute intervals. During the firing of the zinc there is no effort made to raise or maintain furnace temperature. If after three firings of zinc the draw trials do not show a satisfactory glaze, a fourth trial firing is made in the manner described, at the expiration of a twenty-minute period.

At the end of this fourth firing of zinc, the furnace has lost so much heat that a fifth firing of zinc cannot be volatilized. Due also to the

fact that the brick around the bag walls have been softened by the reducing fires preliminary to vapor glazing, it is impossible to rebuild the fires in the furnaces and to make a repetition of the entire vapor-glazing process without causing the entire kiln of brick to be badly overfired and stuck.

The penetration depth of the green glaze into the brick is immediately determined by draw trials. If the draw trial is satisfactory, the kiln is closed by dropping the damper and sealing the furnaces with mud-daubed brick.

Cooling The kiln is held sealed as tightly as possible for 24 hours. At the end of 24 hours, the kiln is connected to the waste-heat drier. As far as possible, cooling is accomplished by back-drafting. Crown covers and furnace stops are not removed until the kiln has cooled to a black heat.

Development of Vapor-Glazing Procedure

Experiment No. 1 The brick were fired to vitrification under oxidizing conditions using the same method of firing as used in firing a kiln of red brick. The furnaces were then cleaned and a good bed of fire built in each. An hour was required to build up the furnace temperature, during which time the furnaces were gradually closed and the kiln atmosphere became reducing.

Three hundred pounds of pig zinc were prepared by sledging into pieces of two or three pounds each. Three hundred pounds of salt were distributed between two wheelbarrows.

All being ready with stack damper open, four men proceeded around the kiln in the following manner: the first man pushed the coal back from the coking plate; the second man shoveled three shovelsful of salt as far back into the furnace as possible; the third man threw in three chunks of pig zinc; the fourth man then restopped the furnace door with slack coal.

As soon as zinc and salt firing was completed, the damper was dropped in the stack flue to within three inches of the bottom. The vapor from the stacks immediately became white, showing volatilization of the salt and zinc. In twenty minutes this vapor had almost disappeared from the top of the kiln stack. The damper was then lifted and firing of the zinc and salt was repeated.

Three firings of zinc and salt were made. Twenty minutes after the last firing of zinc and salt all of the coal and ashes were shoveled out of each furnace. The goose-neck connection to the drier waste-heat flue was inserted in one kiln door and the other kiln door was torn down. The crown cover was removed from the top of the kiln. Every effort was made to cool the kiln as quickly as possible, the idea being to quench the zinc glaze on the brick.

There were a few green brick around the furnaces and over the top of the kiln. The bulk of the brick in the kiln were light chocolate in color, shading to red in the bottom of the kiln.

The green color on the brick around the bag walls was good. Many brick near the kiln doors and over the top of the kiln were shattered. The waste-heat drier was filled with zinc fumes and the brick in the drier were coated with a white deposit, probably zinc oxide. The idea of quenching was abandoned.

Experiment No. 2 The firing was conducted as previously described. Pig zinc and salt were prepared as in Experiment No. 1. No change was made in the firing of zinc and salt into the furnaces. At the conclusion of the zinc firing, the damper was dropped in the stack flue and as soon as the coal had burned down in the furnaces to permit their being closed, both the ash pit and the door openings were closed with brick and the brick daubed with mud. The kiln was left tightly sealed for a period of 24 hours and at the end of this 24-hour period, the goose-neck connection was made to the drier flue through one door and three or four brick were knocked out of the top of the opposite door.

More green brick were produced than in Experiment No. 1.

The best brick were around the bag walls, being blue-green in color, and the top courses of the kiln were of a good green color. From the top of the kiln the brick shaded gradually to a red at the bottom. By the setting used, a much more uniform distribution of zinc vapor was obtained through the kiln and there were fewer warped brick than by the setting used in Experiment No. 1. The tie courses, being only one brick in thickness, were generally warped or broken.

Either an insufficient amount of zinc was being used or not enough firings of zinc. It was decided to use more zinc.

Experiment No. 3 A quantity of scrap zinc in the form of sheared pieces from zinc plate had been obtained for this experiment; 500 pounds of zinc shearings were divided into three portions and fired with salt as outlined in the first two experiments. The method of cooling the kiln was the same as in Experiment No. 2.

A much larger quantity of green brick was secured. The color was a yellowish green instead of the blue-green desired. Over one-half of the brick in the kiln had been glazed by the zinc and the color extended from the top of the kiln to the bottom of the outer ten courses of the flat-set brick. The brick which were faced in the bottom of the kiln were green on the flat sides and the green color penetrated sufficiently between the faced brick to make a ring of color.

The experiment showed that an insufficient amount of zinc had been used in the previous experiments.

Experiment No. 4 Methods of setting and firing were unchanged from Experiment No. 3. Five hundred pounds of zinc scrap filings were mixed with three hundred pounds of salt in the wheelbarrows and the zinc and salt were fired together.

Instead of being green glazed, the brick were mustard color, almost golden. The vapor glaze had penetrated to all parts of the kiln and two-thirds of the flat-set brick were graduated from golden yellow around the bag walls and over the top of the kiln to a dull gold one-half way down the kiln, and to red brick, tinted with gold, in the lower part of the kiln. The mustard-colored brick found a good demand and were used in facing several dwellings which at a distance of three hundred feet appeared as fireclay brick. The brick from these kilns which were not thoroughly colored were almost unsaleable as a slight mustard tinge was not pleasing.

It seemed that pure pig zinc gives a blue-green color, scrap zinc, a yellow-green color, and zinc scrap filings fired with salt, a mustard color.

Experiment No. 5 The method of setting was changed to obtain freer circulation. Three hundred pounds of pig zinc broken in fragments were used with three hundred pounds of scrap zinc sheared pieces and three hundred pounds of salt. The salt was fired first, pieces of pig zinc second, and the zinc scrap last, in each furnace. The kiln was tightly sealed for twenty-four hours and at the end of the twenty-four-hour period was connected to the drier and the damper was lifted two inches from the bottom of the stack flue.

Nearly one-half of the flat-set brick in the kiln were of a good blue-green color. The brick around the bag walls and over the top of the kiln had the best color, the color shading toward the center of the kiln from a blue-green at the bag walls and top to a yellow-green color in the lower set brick.

Experiment No. 6 In the experiments previously described, two kilns were used repeatedly. Due to some repair work being necessary on one of these kilns another kiln was used. The methods of setting, firing, and cooling were the same as in Experiment No. 5.

A rather indifferent kiln of green glazed brick resulted. All of the firing and green glazing methods had been carefully followed. In the meanwhile, the kiln previously used for green glazing had been repaired, set, and fired for a red firing. Upon opening the kiln, a considerable number of brick, face set for red firing, were found to be green colored upon the flat faces.

Because of the absorption and revolatilization of the green glaze by the kiln walls and crown, it is desirable to use the same kiln repeatedly for green glazing.

Experiment No. 7 No change was made from Experiment No. 5, except that no salt was used. Three hundred pounds of

pig zinc broken into fragments and three hundred pounds of zinc scrap shearings were fired.

The kiln of green glazed brick obtained did not differ in color from the kilns in which salt was used. The only noticeable difference was an absence of glitter in the green glazed brick.

The green color obtained was considered preferable to the green where the salt was used and the absence of shine an improvement. It was therefore decided not to use salt in green glazing.

Conclusions to Experimental Firings

Amount of Zinc to Use The success of the operation depends upon several factors besides the quantity of zinc. Excellent results were obtained with the use of three hundred pounds of pig zinc and three hundred pounds of zinc-sheet scrap in the 32-foot diameter kilns holding eighty thousand brick each. Fifty per cent of the flat-set brick were glazed to a good green color. The remainder of the flat-set brick in the kilns were yellow-green in color. These slightly greened brick were found excellent for mingled shade range as they soften the range and avoid harsh contrasts. Several large residences were built entirely of the slightly greened brick and are beautiful with a soft range of red, green, and brown colors.

Quality of Zinc The purer the zinc, the better the color. The indications are that moss zinc would produce the best colors.

Pig zinc is hard to break into the small pieces as required for quick melting and volatilization. There is a waste in pig zinc by large pieces melting and running through the fire instead of being volatilized.

Moss zinc should volatilize more readily and more completely and should be more effective.

Scrap zinc contains lead as impurities and does not produce the desired blue-green glaze, but gives a yellowish green color. A mustard-colored brick, which at a distance of five hundred feet appears as a light buff, can be produced with zinc scrap filings and packing house salt mixed together without pig zinc. Several residences were built at Greensboro, N. C., using these mustard-colored brick, which at a short distance appear to be fireclay brick.

Influence of Salt It was thought at first that salt was a necessary part of the vapor glaze, and considerable salt was used. Later experiments determined that in producing green brick with zinc, salt neither helps nor hinders.

In producing mustard-colored brick with zinc scrap filings, an equal quantity of salt seems to be necessary for the best results. Waste salt from meat packing houses is best and cheaper as it is soaked with animal

oils. The combustion of this oil helps to maintain a high furnace temperature.

Influence of Texture upon Green Glaze

Hard-rolled rug texture makes green glazing a matter of penetrating the heat-softened brick with a sufficient quantity of the green glaze to mask the normal red color entirely. On a textured brick not hard rolled (produced as an experiment) the green color was deeper. The penetration of glaze was not deeper in the loose-textured brick than on the hard-rolled textured brick, but the looser texture exposed a greater depth of colored material and therefore appeared greener.

Smooth brick, green glazed, were not pleasing in appearance. Matt textured brick took the green color in a pleasing manner.

Pre-Cambrian vs. Triassic Shale

Following the production of green glazed brick at Monroe, other face brick plants in North Carolina introduced vapor glazing. Those in the pre-Cambrian belt met with success. The plants using Triassic shale have not, to date, produced good green brick.

Chemical Analysis of Finished Product

A chemical analysis of this green glaze, made by Louis Trostel of Baltimore, Md., is as follows:

Loss on ignition	0.42	CaO	0.38
SiO_2	64.00	MgO	2.10
Al_2O_3	18.85	Combined alkalis	3.76
Fe_2O_3	8.34	ZnO	1.04
TiO_2	1.03		
		Total	99.92

This analysis, reduced to an empirical formula, is

$$\left.\begin{matrix} 0.402\ KNaO \\ 0.056\ CaO \\ 0.435\ MgO \\ 0.107\ ZnO \end{matrix}\right\} \quad \begin{matrix} 1.536\ Al_2O_3 \\ 0.436\ Fe_2O_3 \end{matrix} \quad \left\{\begin{matrix} 8.866\ SiO_2 \\ 0.107\ TiO_2 \\ 1.938\ H_2O \end{matrix}\right.$$

Zinc oxide has a decided action in producing colors in both clear and matt glazes. Ross C. Purdy gives the following reasons why zinc oxide is used in glaze for vitrified and semi-vitrified bodies. It improves color, gives more gloss, gets away from the egg-shell finish, helps to correct or obviate crazing, gives longer heat range in the glaze, and is of great assistance in obtaining easier fusibility; thus the use of zinc oxide alters the colors obtained with underglaze decorations. Some are destroyed by an excess of zinc and others are improved.

In other glazes, zinc is not itself a coloring agent, but is active in producing colors. Red brick which accidentally fall into the kiln furnaces in process of firing, become greenish black in color. This greenish black

color is evidently caused by reduction of iron and absorption of carbon. Knowing the function which zinc has in other glazes it is possible that in this green glaze, the iron is similarly affected by the zinc, with the resulting green color. This theory of the green color being a form of iron is borne out by the fact that exposure of the glazed brick to air, when hot, results in an oxidation of the green glaze, and a change in color from green to brown.

Color Flashing

The pre-Cambrian shales also produce beautifully flashed colors: browns, blues, and blacks. To produce blue and glossy black brick, the kiln was set flat as previously described and fired under oxidizing conditions. When the brick had been fired to the desired hardness, the furnaces were carefully cleaned and clinkered.

By careful firing, the temperature in all furnaces was raised to maximum. The furnace openings were then closed with slack coal to concentrate the heat in the furnaces. While this was being done a mixture of coal tar and slack coal was prepared at each furnace. As much tar was added to the slack coal as the coal would absorb. When all was ready and the furnaces were in proper condition, with stack damper wide open, a crew of three men proceeded around the kiln. One man, his shovel inverted, pushed the coal from the coking plate. The next man shoveled three shovelsful of mixed tar and slack coal as far back into the furnaces as possible. The third man then replaced the slack coal in the furnace opening entirely blocking it. When the crew had proceeded entirely around the kiln, the damper was dropped to within four inches of the bottom of the stack flue. The kiln of brick was allowed to soak in this reducing atmosphere for twenty minutes. Then the damper was again raised and the operation repeated until three firings of the coal tar had been used. At the end of the three firings the damper was entirely dropped and the ash pits and furnace doors were bricked up and plastered with clay.

Any holes which burned in the furnace stoppings of slack were repaired. At the end of one hour the furnaces were entirely filled with all the coal that could be shoveled into them and the furnace mouth was bricked up. The kiln was then sealed and allowed to remain for twenty-four hours. At the end of this time a hole was broken in one kiln door for the insertion of the waste-heat drier connection. No openings were made in the opposite kiln door and furnaces for the admission of air to the kiln until it had been off fire forty-eight hours. The idea was to cool the kiln down under as near a reducing condition as possible. An entire kiln of purplish black brick was secured from this normally red firing shale and was without glaze.

A glazed or glossy black brick was secured by proceeding as above, except that in addition to the mixture of coal tar and slack coal, three

shovelsful of packing-house salt were fired to each furnace with the tar slack mixture. When unable to secure packing-house salt, ten quarts of black oil were used to a wheelbarrow of salt. Oil offsets the endothermic reactions resulting from volatilization of the salt. The kiln was cooled under reducing conditions as described and the brick secured were a glossy jet black in color.

Conclusions

Vapor Glazing Pre-Cambrian shales will take a satisfactory zinc vapor glaze.

Brick must be carefully set flat in a manner to avoid warping, and in a manner to expose at least one end and the face.

It is important that brick be first fired to vitrification under oxidizing conditions.

Preparatory to vapor glazing, kiln furnaces must be carefully cleaned and the furnace temperature raised to maximum.

The purer the zinc the better the green color.

Scrap zinc contains impurities which produce a yellowish green glaze.

Moss zinc should produce more and better green brick because it is pure zinc and in a form to be more quickly volatilized than fragments of pig zinc.

Quantity of zinc is important, but must be determined for each shale or clay.

The cost per thousand brick is small compared to increased value.

Salt is not necessary to produce green color but it does give the brick a glossy appearance.

Following zinc vapor glazing, the kiln should be sealed until the zinc vapor has been completely absorbed and cooling done by back drafting.

To take advantage of absorption of zinc glaze by kiln walls, the same kiln should be used successfully for zinc glazing.

Color Flashing The pre-Cambrian shales are suitable for color flashing to produce brown, purple, and black brick.

The brick must be set flat in a manner to avoid warping, and to expose at least one end and the face.

The brick are fired to vitrification under oxidizing conditions.

A clean fire and white hot furnace are necessary to properly volatilize the salt and tar.

The use of coal tar with the coal produces an intense reducing atmosphere in the kiln.

Use waste salt from meat packing or add oil to the salt to counteract endothermic reaction of volatilization of the salt.

To secure the maximum black or purple brick, cool the kiln under reducing conditions.

Salt is not necessary to secure black color, but without the salt glaze the brick appear purple.

Carolina Fireproofing Company
Gulf, N. C.

ALTERING THE PROPERTIES OF HEAVY CLAYS BY THE USE OF ELECTROLYTES[1]

By Tajamul Husain[2]

ABSTRACT

Some heavy clays otherwise adaptable to industrial use have poor working properties. The possibility of altering these properties beneficially, by the addition of electrolytes to the clays, was investigated. The effects of acids and bases, or those salts which when hydrolyzed, reacted as acids or bases, gave the most promise. Physical properties were determined in the laboratory, on three clays in the green and fired states, without electrolytes and with hydrochloric acid, tannic acid, sodium carbonate, and calcium chloride. Some plant tests were also made, particularly on drying. It was found that the addition of electrolytes improved the properties of some clays, the electrolyte and amount required being individual with each clay.

Introduction

Many clays show excessive shrinkage, laminate unduly, or show a persistent tendency to crack during the drying process. Having had some success with the use of electrolytes with a difficult clay, it was decided to gather more specific information. Alteration of the physical properties of clays by electrolytes has been largely confined to the whiteware clays; very little to clays used in the heavy clay industries.

It is unlikely that the influence of added electrolytes would be so easily predictable with the clays and shales used in heavy clay products as in the case of kaolins and ball clays. In addition to their impurity, the small amount of water used and the method of preparing heavy clays for the forming process does not bring the clay completely into contact with the suspending medium (water). This militates against realizing the maximum effect of a given electrolyte.

Purpose[3] The information which is of interest is (1) the flow of the clay through the die, (2) rate of drying, (3) strength, (4) porosity, and (5) the effect of these properties on cracking during drying. The laboratory work had to do with tests which would serve to indicate which electrolyte (and in what concentrations) would alter a given clay so as to meet certain requirements in service.

Literature The literature applicable to this subject is in part as follows:

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[1] Investigation at Ohio State Univ., and the Ohio State Univ. Eng. Expt. Sta., Roseville, Ohio, and presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929 (Heavy Clay Products Division). Received June 26, 1930.

[2] Research Fellow, The Ohio State Univ., Eng. Expt. Sta., Columbus, Ohio.

[3] Only such data as are pertinent to the commercial application of electrolytes to clays are presented herein. For the complete data covered in the laboratory tests, the reader is referred to the author's thesis, which is on deposit at the Ceramic Seminar Library, Ohio State University.

P. Rohland, "Die Mittelzur Anderung des Plästizitäts-grades der Tone," *Sprechsaal*, Vol. 39, p. 1371.

H. E. Ashley, "The Technical Control of the Colloid Matter in Clays," *Trans. Amer. Ceram. Soc.*, **12**, 768 (1910).

A. V. Bleininger and C. E. Fulton, "The Effect of Acids and Alkalis upon Clays in the Plastic State," *ibid.*, **14**, 827 (1912).

Robert Back, "Effects of Some Electrolytes on Clays," *ibid.*, **16**, 551 (1914).

H. F. Staley, "Effect of Salt on the Drying Behavior of Clays," *ibid.*, **17**, 697 (1915).

E. G. Acheson, "Effect of Addition of Organic Compounds," *ibid.*, **6**, 31 (1904).

H. G. Schurecht, "The Effect of Electrolytes on Some Properties of Clays," *Jour. Amer. Ceram. Soc.*, **1**, 201 (1918).

F. C. Westendick, "The Effect of Soluble Salts upon the Physical Properties of Some Ohio Clays," Thesis, Ceramic Department, Ohio State Univ.

T. W. Garve, "Diluent Effect on Drying Behavior of Plastic Clays," Thesis, Ceramic Department, Ohio State University.

Preliminary Investigations

Materials With mental reservations as to what could be expected from a study of a limited number of clays and using only a few routine tests, three representative clays, quite different in their physical properties, texture, and appearance were selected. One was a dense-firing shale, the second an open-firing alluvial clay, and the third, a mixture of open-firing lake bottom shale and clay. These three clays could be expected to be altered by the addition of electrolytes since they were fine grained.

Clay E-1 (Bedford shale) was obtained from the stock bins of a face brick plant in central Ohio. It is a red, soft, highly plastic shale, which slakes readily. It is inclined to fire to a dense body before the desired color is developed in the product.

Clay E-2 (alluvial clay), a surface deposit near Hattiesburg, Miss., is characteristic of the clays covering a large area in the Gulf States. It is somewhat similar to bentonite. This clay is used for making dry-pressed face brick and stiff-mud common brick, both of a poor quality. The color of the clay varies with the iron content from a fair buff through a purple to a good red. When mixed with water it has a soapy feel and takes up much water, but only very slowly. It cracks badly at the ordinary room temperatures. Microscopic analysis shows this clay to consist of quartz 35%, flint 5%, clay substance (index 1.53) 55%, and accessory minerals 5%.

A 50–50 mixture of clay E-3 (Erie shale) and glacial clay is used at a structural tile plant in northern Ohio. It is fine grained, but not particularly plastic, due to a high content of an extremely finely-divided sand. Ware made from this mixture shows a high shrinkage and considerable tendency to crack during drying.

In addition, a Chicago surface clay was used to check certain of the laboratory tests. This clay when used for large tile shows considerable tendency to crack during drying.

TABLE I

CHEMICAL ANALYSIS OF CLAYS

	E-1	E-2	E-3
Ignition loss	6.07	3.27	7.70
SiO_2	59.63	82.26	64.30
Al_2O_3	18.33	8.44	14.50
Fe_2O_3	6.47	3.54	5.20
TiO_2	1.09	1.02	1.00
P_2O_5		Trace	
CaO	0.98	0.27	1.20
MgO	1.04	0.39	0.60
K_2O	3.07	0.71	0.34
Na_2O	1.58	0.41	0.42

TABLE II

SCREEN ANALYSIS OF CLAYS (DRY AS RECEIVED)

	Per cent by weight retained		
Mesh	E-1	E-2	E-3
On 20	8.22	5.55	0.19
" 48	28.72	20.29	18.38
" 65	8.46	6.35	10.95
" 100	9.14	6.76	12.30
" 150	5.75	5.16	8.31
Through 150	38.35	55.41	48.78

Pilot Tests Made A series of tests were run to determine which electrolyte would prove most successful. Several salts which might give promising results were not included due to prohibitive costs. Ferric chloride and aluminium chloride were in this class. Sodium chloride, most commonly used, proved to be the least effective of all. Lime gave considerable promise with one clay but increased cracking in the other two.[4]

Electrolytes and Their Preparation The four electrolytes[5] chosen for the laboratory tests were (1) hydrochloric acid, (2) tannic acid, (3) sodium carbonate, and (4) calcium chloride; being a strong inorganic acid, a weak inorganic acid, a strong base, and a divalent salt, respectively. These reagents were chosen for their solubility, low cost, and previously proved effectiveness in some cases. Con-

[4] Acids and bases or those salts which hydrolyze, forming acids or bases, gave the greatest promise.

[5] Chemically pure hydrochloric acid was used; specific gravity 1.1878 to 1.1914; HCl 37 to 38.5%. The tannic acid was the purest available. Chemically pure anhydrous sodium carbonate and granular C.P. calcium chloride were used. The latter was heated to 110°C and then was placed in an electric furnace for one hour at 500°C; the per cent water was thus found to be 8.22.

sideration was given to the possibility of the electrolytes scumming the ware and to the facility with which they could be handled at the plants.

Effect on Clay Settle Ten grams of the clays (through 100-mesh) were placed in graduated cylinders and the electrolyte solutions were added to the 200-cc. mark. The cylinders were shaken for four minutes and then allowed to stand for settle. The time required for settling and the cubic centimeters settled in each instance was noted. See Tables V, VI, and VII.

Effect on Slaking The tendency[6] was for all electrolytes except sodium carbonate to decrease the slaking time of clays E-1 and E-3, although E-1 is little affected by tannic acid. These data are most interesting in that they do not fit into the other data as ordinarily interpreted.

Effect on Viscosity Clay-water and clay-water-electrolyte suspensions were made and their time of flow compared with that of pure water.[7]

Hydrochloric acid had a marked effect in retarding the rate of flow of all the clays. The outstanding fact was that varying the concentration (within the limits used) did not show any quantitative effect on the rate of flow. This should be further investigated before stating any definite conclusions.

The tannic acid retarded the flow to some extent in the case of all the clays.

Calcium chloride had relatively little effect except on E-2 at high concentration (1%).

Sodium carbonate did not increase the rate of flow above that of the clay-water ratio mix as was expected. The soluble salts in the clay may account for this apparent failure to follow along expected lines.

In the case of most of the electrolytes there was more than one low viscosity point due doubtless to the chemical reaction of the added electrolytes with the impurities in the clays.

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[6] Two methods were used: (1) that suggested by the Standards Committee of the AMERICAN CERAMIC SOCIETY and (2) that used in the laboratories of the U. S. Bureau of Public Roads (F. H. Eno, Highway Research Board, 6th Amer. Proc., pp. 142–46), are essentially different only in preparation of the test samples. The AMERICAN CERAMIC SOCIETY method is not only the simplest procedure but simulates more closely the conditions obtained during the slaking of clays in practice. The data given in the tables are those obtained by the AMERICAN CERAMIC SOCIETY procedure.

[7] A pilot series of tests was run to determine the best clay-water ratio to use. A ratio of 100 grams of clay in 150 grams of water worked well for all the electrolytes except HCl. This ratio made a slip too stiff to flow at some of the concentrations. It should be especially noted that a ratio of 100 clay, 175 water was used for this reagent. Had this ratio been used for all the electrolytes their variation from pure water would have been too small to be significant.

Laboratory Stiff-Mud Tests

To relate the results obtained with the clays in slip form to the heavy clay process of manufacture, tests were run on stiff-mud bars made up by hand.

Pug Water For each clay, the ratio of solution to clay was kept constant for all tests. The amount of pug water required by the different clays was, of course, different. The amount of liquid to be used was determined by trial until bodies of a stiff-mud consistency were obtained.

Only the concentrations of electrolyte found to be most effective in the previous tests were used (0.5%, 0.25%, and 0.05%). In the case of clay E-1, 0.0083% was also used. With clay E-2, some additional tests on drying behavior were made with 1.0% tannic and hydrochloric acids.

Aging Three thousand grams of clay were used for each batch. The batches were allowed to age for 18 to 20 hours in covered stoneware jars.

After the bodies were aged they were hand molded in 6- by 1- by 1-inch bars. They were dried at room temperature for 48 hours and then placed in an electric oven at 107°C for ten hours. The bars were then cooled in a desiccator.

Drying Behavior Clay E-1 in general showed no cracking or warping when dried at room temperature or subsequently at 107°C, the exceptions being with the tannic acid concentrations of 0.05% and 0.5% which warped.

Clay E-2 cracked badly in all cases within an hour at room temperature with the exception of the bars made with 0.5% HCl. The use of this concentration eliminated cracking and warping both at room temperature and subsequently at 107°C. One per cent HCl bars showed only slight cracking. As the concentration of this reagent decreased from 0.5% to zero, the cracking increased. Tannic acid in 1% solution gave only very fine hair cracks. With this concentration of tannic acid, the warping was slight. Cracking and warping increased with decrease in the concentration of tannic acid.

None of the clay E-3 bars developed cracking or warping when dried at room temperature, but at 107°C cracking developed in the bars made from water alone, and with 0.25% and 0.5% concentrations of $CaCl_2$.

To accentuate the cracking, 3- by 3- by 1-inch test pieces were hand molded. These tile were placed when wet in an electric oven at 107°C, where they were left for five hours.

Clay E-1 dried safely with this procedure as did clay E-3, except that containing pure water alone, $CaCl_2$ in percentages of 0.5% and 0.25% and all concentrations of Na_2CO_3. All samples of clay E-2 cracked with the exception of pieces made up with 0.5% HCl which dried safely.

Rate of Drying Cubes, 1 by 1 by 1 inch, were cut from hand-molded bars. Two cubes of each mix were suspended in an oven maintained at 107°C. Weighings were made at 5-minute intervals until constant weight was attained. The time required for complete drying was recorded. (See Tables V, VI, and VII.)

The time of drying for clay E-1 with water is five hours and 48 minutes. In each case electrolytes increased the required time. With 0.05% HCl, however, which is second to water in rate of drying, the time is only 15 minutes longer. Tannic acid retards the drying most, making the time required almost twice that with water alone. The drying time in general increases with the concentration of the electrolytes.

With water alone, clay E-2 dried in 12 hours and 37 minutes. With 0.5% HCl, it dried safely and it is interesting to note that the same concentration of HCl lowered the drying time to 10 hours and 11 minutes. All other concentrations of all electrolytes increased the time of drying. As the concentration of HCl is lowered the time required for drying is increased.

Clay E-3 dried more rapidly with all concentrations of HCl than with water alone, the highest concentrations being the most effective. All of the other electrolytes in all concentrations increased the drying time over that of pure water.

Other Data on Pilot Series Data were also obtained in the laboratory stiff-mud tests as follows: (1) unfired porosity, (2) fired porosity, (3) drying shrinkage, (4) firing shrinkage, (5) unfired modulus of rupture, (6) fired modulus of rupture, (7) modulus of elasticity, and (8) fired appearance.

Tests on Chicago Clay An abbreviated series of tests were run on a surface clay from the Chicago district which causes trouble in forming large tile. Drier losses are high and when fired these tile are weak. Six-inch tile and end-cut brick were made up on a small auger machine. The tests were run to determine whether any improvement could be expected in drying and in the strength of the clay. The effect of the time of pugging was determined.

The laboratory data using the two electrolytes which gave the greatest promise and the test on the effect of pugging follow:

TABLE III
CHICAGO SURFACE CLAY
EFFECT OF PUGGING

Pugged with H_2O (time in min.)	Modulus of rupture		Absorption	Shrinkage (%)		Condition of ware
	Green	Fired	%	Green	Total	
1	502.40	2105.0	7.97	3.03	9.35	Hair cracks; scummed
2	570.80	2230.0	7.84	3.00	9.21	Smooth
4	677.00	2117.0	7.11	2.98	9.01	Pimpled
6	605.00	2090.0	6.12	2.98	9.02	Pimpled and swelled

EFFECT OF ELECTROLYTES
(All Pugged Twice before Bars and Bricks Were Made)

Electrolytes Used Concentration						
Water	480.96	2059.5	7.75	3.10	9.40	Hair cracks; scummed
0.25 H_2SO_4	686.26	2788.0	10.09	2.86	8.91	No cracks; good color
0.50 H_2SO_4	690.51	2809.0	11.80	2.81	8.98	No cracks; trace of scum
1.00 H_2SO_4	701.80	2668.0	9.89	2.80	8.81	Hair cracks; scummed
2.00 H_2SO_4	580.50	2257.0	9.10	2.85	8.70	Hair cracks; scummed
0.25 alum	513.70	2330.0	8.10	3.11	9.45	Cracked badly; good color
0.50 "	665.80	2464.0	8.50	3.10	9.48	Cracked; good color
1.00 "	621.50	2409.0	9.10	2.38	9.01	Cracked slightly; good color
2.00 "	692.20	2651.0	9.90	2.96	8.90	Hair cracks; good color

Plant Tests: Clay E-1

As stated, E-1 is a dense-firing shale, which has no other defect than that the desired color (cherry red) cannot be developed without producing a very dense ware. Some slight tendency to scum is a contributing factor to the failure to get the desired color. The laboratory test showed that none of the electrolytes had any marked effect on the porosity of the fired ware, when fired under identical conditions as the clay-water bodies, with the single exception of a high concentration (1%) of tannic acid. Some slight improvement in color appeared to have been produced by the hydrochloric acid at 1% concentration.

Brick were made up (stiff-mud) and dried at the experimental plant, using 1% tannic acid and $^1/_2$% hydrochloric acid. The brick were fired in accordance with the regular plant practice (tunnel kiln, cone 4 in 96 hours).

The color was improved perceptibly by the hydrochloric acid treatment but not sufficiently to justify installing the process, since there was no improvement in porosity. The tannic acid appeared to give a more open structure but due to the fast heating schedule some of the brick showed a marked tendency to bloat. The same tests are to be carried out in a periodic kiln using a slower firing schedule.[8]

Plant Tests: Clay E-2

Making and Drying Brick were made by the stiff-mud process at two machinery company plants under the supervision of the author. Five sets of 50 brick each were made at each plant. The sets were (1) clay-water, (2) clay-0.5% HCl solution, (3) clay-1% HCl solution, (4) clay-20% sand-0.5% HCl, and (5) clay-20% sand.

All of the brick of sets (1) and (5) cracked badly. No brick from sets (3) or (4) cracked. A few of the brick from set (2) showed fine cracks. Hollow tile made from batch (4) showed no cracks. No special precau-

[8] The price of tannic acid is prohibitive for use in the heavy clay industry, but a by-product from the bi-sulphate process in paper manufacture, which contains considerable tannic acid and tannates can be used to advantage.

tion was exercised in drying the brick except that they were allowed to dry in a warm room and were covered with light weight burlap.

Firing The brick were fired in kilns of three different plants to cones 02, 01, and 2. No additional cracks developed during firing at any of the plants.

The acid treatment was eminently successful with this clay.

Plant Tests: Clay E-3

Clay E-3 was first tested out at the experimental plant with (1) 0.5% HCl, (2) 1% HCl, (3) 1% $CaCl_2$, and (4) 2% Bindex solution. Bindex is a bi-sulphite liquid residue and contains approximately 40% tannic acid. The most satisfactory results were obtained with 0.5% HCl solution.

Factory Run Commercial tests were run at the plant where the clay is used. Little trouble is experienced except when making large hollow tile. Under the most unfavorable conditions drier cracks may cause a prohibitive loss. The usual practice is to use a considerable amount of a more plastic but less available clay with the E-3 shale when making the large tile. The practice is expensive and not entirely satisfactory since lime pebbles are likely to occur from time to time in the plastic clay (glacial origin).

A great variety of electrolytes were tried out, each over a period of several hours' operation. The tests covered a period of several weeks. During this time, the following electrolytes were used in various concentrations: (1) hydrochloric acid, (2) sulphuric acid, (3) Bindex, (4) lime, (5) alum, (6) calcium chloride, (7) sodium carbonate, and (8) sodium chloride. All solutions were made up in a system of two tanks, one a stirrer and the other a storage tank which had formerly been used for barium. The solution was added in the same way as is barium.

The strong acids were the most effective, and common salt the least effective. Lime appeared to give some promise. The sulphuric and hydrochloric acids in 1% concentration were the most effective. The sulphuric acid appeared to reduce rather than to increase the scum. Sulphuric acid is less expensive than hydrochloric acid and is less corrosive when concentrated and more easily handled by automatic pump devices. The price ratio for equivalent hydrogen ion is about one to four, as compared to hydrochloric acid. The sulphuric acid treatment will cost about two cents per ton of clay treated for the acid alone. Other factors not yet evaluated will raise this figure somewhat.

Under identical operating conditions, when using two parts of shale and one part of clay, the drier loss was reduced from 40% with water to less than 5% with 1% acid solution.

Under the normal conditions of operation, using the clay and shale in equal parts, the loss dropped from 13% to a little over 3% with 1% acid

solution. Some tabulated notes on some of the electrolytes used are given below:

TABLE IV

EFFECT OF ELECTROLYTES ON CLAY E-3

Electrolyte (%)	Drier breakage (%)	Appearance
Two parts shale : one part clay		
Water alone	40.08	Scum with white lines
0.25 HCl	23.4	White lines
0.5 HCl	17.8	More scum; white lines present
1.0 HCl	4.2	Scum only on bottom tile on car
0.25 H_2SO_4	20.1	Scum; but no white lines
0.5 H_2SO_4	16.8	No scum; lines slightly evident
1.0 H_2SO_4	4.8	No scum; uniform color; no lines
0.25 $CaCl_2$	27.0	Little less scum than with water
0.5 $CaCl_2$	18.0	Same as with 0.25% $CaCl_2$
1.0 $CaCl_2$	13.1	Scum worse; also white lines
One part shale:one part clay		
Water alone	13.1	Scum with white lime spots
0.25 HCl	26.0	Similar to body with water alone
0.5 HCl	7.1	Slight improvement
1.0 HCl	3.3	Improvement; white line visible
0.25 H_2SO_4	15.2	Very little scum; some spots
0.5 H_2SO_4	5.6	Color good; a few white lines
1.0 H_2SO_4	3.2	Color uniform; no scum
2.0 H_2SO_4	11.2	No scum or spots; color lighter
0.5 Bindex	9.1	Slight increase in scum
0.25 $CaCl_2$	26.0	Increase in scum with white lines
0.5 $CaCl_2$	18.1	" " " " " "
1.0 $CaCl_2$	17.2	" " " " " "

It is important to note that some of the electrolytes caused more rather than less cracking, as compared with water, and that the changes in concentration of the same electrolyte changed it from a detriment to a decided advantage.

Conclusions

General conclusions can be drawn from the laboratory and plant tests as follows:

(1) None of the laboratory tests showed the possibilities of becoming a general and simple method for deciding which electrolyte could be expected to give the best results.

(2) The properties of shales and clay can be altered, often over rather wide limits by the addition of electrolytes.

(3) The particular electrolyte most effective and the concentration with which the best results can be obtained is individual with the clay under test.

(4) A given electrolyte will alter a particular property or properties and may or may not affect the other properties.

(5) Some clays are quite sensitive to the action of electrolytes, while others are very little affected.[9]

(6) Plant application of electrolytes to the manufacturing process can aid in drying the ware, altering the porosity, and strengthening the product both green and fired. The drying loss under factory conditions dropped from 13 to 3% on using a 1% solution of hydrochloric acid.

TABLE V

PHYSICAL PROPERTIES OF CLAY E-1, WITH AND WITHOUT ELECTROLYTES (GREEN)

		HCl				$C_{14}H_{10}O_9$		
	H_2O	0.0083	0.05	0.25	0.5	0.05	0.25	0.5
Rate of settle (hrs. and min.)	None	2:35	2:40	1:20	2:30	0:45	1:12	1:45
Volume of sediment (cc.)		24.50	22.30	20.10	22.30	15.00	16.00	20.00
Viscosity (relative to H_2O)	1.09	1.09	1.23	1.15	1.13	1.44	1.22	1.15
Slaking time (hrs. and min.)	1:50	1:25	1:16	0:52	0:13	2:06	1:36	1:36
Water of plasticity	20.00	19.68	21.29	21.47	21.47	19.66	21.26	22.29
Rate of drying (hrs. and min.)	5:48	7:09	6:03	6:58	7:48	8:52	8:52	8:11
Porosity (%)	12.45	11.90	11.87	11.85	12.23	11.50	12.33	12.34
Green shrinkage (%) (linear)	5.26	4.05	3.74	5.27	4.33	5.04	5.20	5.40
Modulus of rupture (lbs. per sq. in.)	375.0	358.0	346.0	324.0	255.0	310.0	290.0	412.0
Modulus of elasticity ($\times 10^{-5}$)	2.59	2.38	2.55	2.14	2.06	2.04	2.27	3.22

	$CaCl_2$			Na_2CO_3		
	0.05	0.25	0.5	0.05	0.25	0.5
Rate of settle (hrs. and min.)	3:20	1:05	1:05	None	7:45	7:30
Volume of sediment (cc.)	29.0	18.5	20.0	..	36.0	30.0
Viscosity (relative to H_2O)	1.49	1.37	1.41	1.28	1.18	1.306
Slaking time (hrs. and min.)	1:35	0:47	0:22	2:01	2:22	2:29
Water of plasticity (%)	22.16	22.16	20.93	22.40	20.16	20.46
Rate of drying (hrs. and min.)	6:50	8:28	7:59	7:70	7:42	8:15
Porosity (%)	11.94	12.66	11.70	11.52	11.80	12.45
Green shrinkage (linear) (%)	5.03	4.93	5.60	4.95	5.64	5.14
Modulus of rupture (lbs. per sq. in.)	290.00	310.00	335.00	363.00	334.00	428.00
Modulus of elasticity ($\times 10^{-6}$)	2.21	2.14	2.26	3.25	1.74	3.38

PHYSICAL PROPERTIES OF CLAY E-1, WITH AND WITHOUT ELECTROLYTES (FIRED)

	H_2O pure	HCl				$C_{14}H_{10}O_9$		
		0.0083	0.05	0.25	0.5	0.05	0.25	0.5
Fired shrinkage (%)	7.39	7.34	6.07	7.58	7.29	6.79	6.95	7.14
Total shrinkage (%)	11.30	10.37	9.10	11.75	10.65	11.00	10.59	11.48
Modulus of rupture (lb. per sq. in.)	4367	5439	5388	4957	5336	5142	4378	5028
Modulus of elasticity ($\times 10^{-5}$)	4.54	2.70	2.51	2.64	2.50	2.59	2.53	3.58
Porosity (%)	0.30	0.19	0.58	0.21	0.63	2.00	2.75	2.15
Absorption (%)	0.13	0.08	0.24	0.09	0.29	1.07	2.46	1.89
Bulk sp. gr.	2.43	2.54	2.43	2.63	2.39	2.44	2.36	2.40
Apparent sp. gr.	2.43	2.45	2.44	2.44	2.41	2.50	2.50	2.45

[9] This conclusion has been verified in later work over a wide range of clays.

TABLE V (*continued*)

PHYSICAL PROPERTIES OF THE CLAY E-1, WITH AND WITHOUT ELECTROLYTES (FIRED)

	$CaCl_2$			Na_2CO_3		
	0.05	0.25	0.5	0.05	0.25	0.5
Fired shrinkage (%)	6.98	6.60	7.80	6.60	7.35	6.38
Total shrinkage (%)	11.00	10.70	12.00	10.56	11.50	10.80
Modulus of rupture (lbs. per sq. in.)	4606	4623	5252	5026	5607	5520
Modulus of elasticity ($\times 10^{-6}$)	2.45	2.25	2.29	2.38	2.30	2.45
Porosity (%)	1.328	2.479	0.5856	0.223	0.1804	0.0564
Absorption (%)	0.556	1.034	0.2461	0.0920	0.0739	0.0232
Bulk sp. gr.	2.397	2.415	2.375	2.429	2.638	2.428
Apparent sp. gr.	2.433	2.473	2.391	2.441	2.67	2.435

TABLE VI

PHYSICAL PROPERTIES OF CLAY E-2, WITH AND WITHOUT ELECTROLYTES (GREEN)

	H_2O pure	HCl			$C_{14}H_{10}O_9$		
		0.05	0.25	0.5	0.05	0.25	0.5
Rate of settle (hrs. and min.)	None	0:51	0:55	0:51	0:36	1:01	0:36
Volume of sediment (cc.)	....	9.9	10.5	10.0	14.8	15.0	16.0
Viscosity (relative to H_2O)	1.151	1.135	1.141	1.179	1.129	1.130	1.171
Slaking time (hrs. and min.)	0:03	0:03	0:04	0:06	0:03	0:03	0:04
Water of plasticity (%)	23.34	23.34	23.34	23.34	23.34	23.34	23.34
Rate of drying (hrs. and min.)	12:37	14:50	15:13	10:16	13:03	14:08	15:30
Porosity (%)	10.01	8.91	9.83	10.65	10.75	10.75	10.62
Green shrinkage (%) (linear)	7.53	8.14	8.28	11.11	7.99	9.92	9.92
Modulus of rupture (lbs. per sq. in.)	....	....	....	459.90			
		All cracked			All cracked		
Modulus of elasticity ($\times 10^{-6}$)	....	....	....	1.42	....	....	....

	$CaCl_2$			Na_2CO_3		
	0.05	0.25	0.5	0.05	0.25	0.5
Rate of settle (hrs. and min.)	0:22	0:31	0:22	1:52	3:55	3:55
Volume of sediment (cc.)	16.00	19.80	15.70	Turbid	76.00	65.00
Viscosity (relative to H_2O)	1.14	1.25	1.82	1.82	1.16	1.18
Slaking time (hrs. and min.)	0:03	0:04	0:05	0:04	0:04	0:05
Water of plasticity (%)	23.34	23.34	23.34	23.34	23.34	23.34
Rate of drying (hrs. and min.)	18:09	18:01	17:02	16:17	16:04	16:03
Porosity (%)	10.81	10.55	10.00	10.03	11.0	10.60
Green shrinkage (%) (linear)	Cracked 7.58			Cracked badly		
Modulus of rupture (lbs. per sq. in.)	"					
Modulus of elasticity ($\times 10^{-6}$)	"					

PHYSICAL PROPERTIES OF CLAY E-2, WITH AND WITHOUT ELECTROLYTES (FIRED)

	H_2O	HCl			$C_{14}H_{10}O_9$		
		0.05	0.25	0.5	0.05	0.25	0.5
Shrinkage (fired) (%)	3.77	3.61	3.61	3.76	3.90	2.65	2.65
Total shrinkage (%)				13.26			
Modulus of rupture (lbs. per sq. in.)				1098			
Modulus of elasticity ($\times 10^{-6}$)				4.04			
Porosity (%)				14.03			
Absorption (%)				6.63			
Bulk sp. gr.				2.11			
Apparent sp. gr.				2.46			

TABLE VII

PHYSICAL PROPERTIES OF CLAY E-3, WITH AND WITHOUT ELECTROLYTES (GREEN)

	H_2O pure	HCl			$C_{14}H_{10}O_9$		
		0.05%	0.25%	0.5%	0.05%	0.25%	0.5%
Rate of settle (hrs. and min.)	1:03	0:59	1:21	1:07	1:18	1:12	1:03
Volume of sediment (cc.)	85.00	10.20	12.00	9.90	20.50	24.50	25.50
Viscosity (relative to H_2O)	1.34	1.31	1.35	1.33	1.29	1.54	1.26
Slaking time (hrs. and min.)	0:14	0:12	0:12	0:11	0:10	0:12	0:15
Water of plasticity (%)	21.54	21.54	21.54	21.54	21.54	21.54	21.54
Rate of drying (hrs. and min.)	7:36	7:31	7:01	6:57	9:12	8:04	9:03
Porosity (%)	13.40	16.07	14.12	14.30	14.55	14.73	14.65
Green shrinkage (%) (linear)	3.89	4.15	4.43	3.56	3.88	3.88	3.76
Modulus of rupture (lbs. per per sq. in.)	606	758	846	795	674	707	783
Modulus of elasticity ($\times 10^{-5}$)	2.96	4.70	3.22	7.02	6.42	2.81	6.99

	$CaCl_2$			Na_2CO_3		
	0.05	0.25	0.5	0.05	0.25	0.5
Rate of settle (hrs. and min.)	2:39	2:14	2:14	None	None	3:55
Volume of sediment (cc.)	22.50	20.20	22.00	Turbid	Turbid	31.00
Viscosity (relative to H_2O)	1.28	1.10	1.12	1.34	1.32	1.44
Water of plasticity (%)	21.54	21.54	21.54	21.54	21.54	21.54
Slaking time (hrs. and min.)	0:10	0:11	0:11	0:14	0:13	0:14
Rate of drying (hrs. and min.)	8:30	8:48	9:01	9:14	9:00	9:05
Porosity (%)	14.61	13.91	13.59	14.91	14.70	12.94
Green shrinkage (%) (linear)	4.10	4.05	4.10	3.88	3.99	3.97
Modulus of rupture (lbs. per sq. in.)	601.0	674	667	608	601	660
Modulus of elasticity ($\times 10^{-5}$)	4.7	4.34	4.47	4.81	4.10	3.50

PHYSICAL PROPERTIES OF CLAY E-3, WITH AND WITHOUT ELECTROLYTES (FIRED)

	H_2O pure	HCl			$C_{14}H_{10}O_9$		
		0.05	0.25	0.5	0.05	0.25	0.5
Fired shrinkage (%)	3.90	3.60	3.57	3.40	2.88	2.56	3.57
Total shrinkage (%)	7.50	7.50	7.60	7.30	6.50	6.16	7.04
Modulus of rupture (lbs. per sq. in.)	1050	1225	1876	1974	1102	1200	1656
Modulus of elasticity ($\times 10^{-6}$)	3.7	2.80	2.62	2.10	2.90	2.86	2.80
Porosity (%)	14.98	15.10	15.80	16.10	16.50	16.20	17.05
Absorption (%)	7.70	7.81	7.24	7.91	8.10	7.98	8.25
Bulk sp. gr.	2.13	2.10	2.02	1.90	2.03	2.03	2.06
Apparent sp. gr.	2.47	2.21	2.40	2.23	2.43	2.42	2.48

	$CaCl_2$			Na_2CO_3		
	0.05	0.25	0.5	0.05	0.25	0.5
Fired shrinkage (%)	3.71	3.70	2.88	3.20	3.50	3.80
Total shrinkage (%)	7.84	7.50	7.00	6.83	7.10	7.40
Modulus of rupture (lbs. per sq. in.)	1705	1765	1858	1665	1689	1779
Modulus of elasticity ($\times 10^{-5}$)	3.80	3.70	3.63	3.25	3.30	3.43
Porosity (%)	14.50	14.30	13.65	16.36	16.10	15.54
Absorption (%)	7.20	7.18	8.20	8.05	7.80	7.30
Bulk sp. gr.	2.00	2.21	2.03	2.03	2.06	2.09
Apparent sp. gr.	2.30	2.51	2.44	2.43	2.09	2.16

CORRECTING TENDERNESS OF A SHALE BY CHEMICAL TREATMENT[1]

By Harold E. Simpson

ABSTRACT

An attempt was made to increase the strength of a tender shale in both the green and dry states. Finer grinding, aging, and the addition of chemicals were the expedients used. Sulphuric acid increased the dry modulus of the shale up to 251% when used in concentrations up to 10%. This benefit was offset by a leaching of the color; 0.25% HCl and 0.25% tannic acid increased the dry modulus 42% and 72%, respectively. Organic binders as Bindex and glutrin showed a 100% increase. Two per cent Na_2CO_3 and 1% $BaCO_3$ showed a 60% and 45% increase. Molasses plus yeast improved the machining and the green strength of the shale. Finer grinding of the shale to pass 28-mesh and aging for one week improved the dry modulus 75.7%.

Introduction

The Shale The shale used in this investigation, according to Stout,[2] "belongs to the lower part of the Conemaugh Series directly above the Brush Creek limestone and extends upward nearly to the Cambridge limestone. An appropriate name would be Brush Creek shale." This shale varies in color from light, through red and green, to dark shades. This particular shale is of the greenish type.

The chemical analysis does not show any outstanding characteristics. Its SiO_2 to Al_2O_3 ratio is typical of shales. The Fe_2O_3 (7.24%) may be a little high. The total alkali content (alkalis and alkaline earths 5.28%) is about average for shales. Neither the carbon nor sulphur is high.

This type of shale as a rule fires to a beautiful rich red color and shows relatively few drying and firing abnormalities. It does, however, have poor strength in the green and dry state due to its abnormally low clay content (20%).

Such Conemaugh shales are extremely young, geologically speaking. They represent the remains from old, ground Piedmont schists and sufficient weathering and working has not taken place to develop high clay content and strength.

Literature References The work of this sort is reported chiefly by the following reports:

H. W. Douda, "The Effect of Wet Grinding, Screening, Electrolytes and Dextrine on Clays of Low Plasticity," *Jour. Amer. Ceram. Soc.*, **3** [11], 885 (1920).

H. G. Schurecht and H. W. Douda, "The Properties of Some Claylike Materials of the Bentonite Type," *ibid.*, **6** [8], 940 (1923).

A. J. Paul and M. E. Holmes, "The Effect of Various Addition Agents and Treatment on the Green Strength of Missouri Refractory Clays," *ibid.*, **12** [10], 676 (1929).

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[1] Ohio State Univ., Eng. Expt. Station, Roseville, Ohio. Received April 22, 1930.

[2] State Geologist of Ohio.

TABLE I

Member	Time (min.) 18-cc. vol. settle	Working property	Water of plasticity	Dry shrinkage	Firing shrinkage (cone 3)	Modulus of rupture: Dry	Modulus of rupture: Increase (%)	Modulus of rupture: Fired (cone 3)	Absorption	Firing condition
Green shale alone 12-mesh	16	Poor edges; no strength	19.44	1.01	4.92	198	0	3208	9.0	Good texture; color light; scummed
Blue shale alone 12-mesh	10	Poor edges; no strength	18.32	1.01	5.46	141	28.2−	3015	8.5	Fair texture; poor color; scummed badly
Green shale at end of pit, 12-mesh		Poor strength and edges poor	19.41	1.61	4.91	174	10.3−	2407	10.5	Color light; texture fair; considerable scumming
Green shale alone 28-mesh		Poor strength and edges	20.49	2.47	6.48	204	3.03+	2789	8.16	Color light; texture very good; some scumming
Green shale alone 28-mesh (aged 3 weeks)		Good strength; better plasticity and machining	22.54	2.88	6.79	305	54.0+	3729	8.55	Texture very good; color light; scumming on edges
2% Bindex	*	Poor strength; very little plasticity	17.85	1.69	7.19	425	114.0+	3639	5.83	Color light; a little scumming
1/4% Bindex	*	Poor strength; very little plasticity	19.27	2.22	6.93	300	60.7+	3714	6.82	Fair color; good texture; little scumming
2% Na_2CO_3	29	Poor strength; little plasticity	17.96	2.37	7.02	319	61.2+	3431	5.84	Fair color; good texture; some scumming
1% Na_2CO_3	28	Increase in strength and in plasticity	19.17	1.80	6.12	320	61.7+	3532	6.56	Fair color; good texture; considerable scumming
1/4% Na_2CO_3	22	Poor strength; little plasticity	19.53	2.42	7.06	333	68.3+	3536	7.21	Light color; good texture; some scumming
1/8% Na_2CO_3	*	Poor strength; little plasticity	19.54	2.62	6.15	262	32.4+	3292	7.75	Color good; texture good; little scumming
2% bentonite	*	Fair strength; improved with pugging	18.59	2.40	6.29	286	44.5+	3134	7.14	Color good; texture good; considerable scumming
1/4% bentonite	*	Poor strength; little plasticity	20.06	2.50	6.48	271	36.9+	3452	7.26	Color light; good texture; a little scumming
2% tannic acid	*	Increased strength and plasticity splendid	17.75	2.17	5.80	353	78.4+	3403	7.17	Color light; good texture; some scumming
1/4% tannic acid	*	Poor strength and plasticity	19.09	2.42	6.14	340	71.8+	3371	6.75	Color light; good texture; considerable scumming
2% glutrin	*	Poor strength and plasticity	18.56	2.58	6.50	447	126.0+	3347	7.26	Color light; texture good; some scumming on edges

1/4% glutrin	*	Poor strength and plasticity	21.84	3.14	6.33	311	57.2+	3063	9.27	Color light; texture fair; some scumming on edges
1% $CaCl_2$	15	Poor strength and plasticity	19.00	2.73	6.30	249	25.8+	3030	8.28	Color light; texture fair; some scumming on the edges
1/8% $CaCl_2$	13	Poor plasticity; no strength	19.30	2.77	6.43	224	13.1+	3206	7.7	Color fair; texture good; but some scumming
2/3% alum	16	Fair plasticity; strength showed some promise	18.91	2.43	5.53	233	17.7+	3060	8.66	Color fair; texture fair; considerable scumming
1/12% alum	11	Poor strength and plasticity	20.56	2.82	6.63	251	26.8+	3107	7.60	Color fair; texture good; some scumming
1% dextrine	*	Fair strength and plasticity	18.18	2.15	6.26	276	39.4+	3377	7.41	Color good; texture good; some scumming
1/8% dextrine	*	Poor strength and plasticity	18.20	2.19	6.19	274	38.9+	3050	7.41	Color light; texture good; considerable scumming
10% H_2SO_4	46	Good strength; increased plasticity; the best of all chemicals	18.11	1.71	5.80	696	251.0+	2576	8.10	Color dark and dull; texture fair; some scumming
1% H_2SO_4	31	Poor strength; little plasticity	19.27	2.10	5.51	296	49.4+	3148	8.54	Color light and poor; good texture; considerable scumming
1/8% H_2SO_4	19	Poor strength; little plasticity	19.96	1.52	5.61	260	31.3+	3048	8.05	Color light; texture good; considerable scumming
2% HCl	27	Fair strength; little plasticity	19.68	1.89	6.58	261	31.9+	2755	7.70	Color light; texture good; very little scumming
1/4% HCl	18	Strength poor; very little plasticity	20.10	2.22	6.19	281	41.8+	3312	7.49	Color light; texture good; very little scumming
2% NaCl	20	Poor strength: very little plasticity	19.64	2.33	7.69	300	60.6+	2821	5.78	Fair color; texture good; some scumming
1/4% NaCl	20	Poor strength; very little plasticity	19.45	2.12	6.94	252	25.5+	3770	6.27	Fair color; good texture; some scumming
66% green shale 33% blue shale 12-mesh		Poor strength and plasticity	17.33	1.14	5.13	195	1.51−	2604	8.94	Color poor; texture fair; badly scummed

* Indicates shale did not reach 18-cc. volume in two hours, indicating an infinitely slow rate of settle.

Howells Fréchette and J. G. Phillips, "Correction of an Extreme Case of Cracking in the Drying of Brick," *ibid.*, **12** [3], 153 (1929).

Tests Made

Settle The sample is ground to pass a 100-mesh screen. A 10-g. sample is placed in a 250-cc. graduated cylinder. A chemical solution of desired strength is then added up to the 200-cc. mark, the mixture shaken slowly for 4 minutes, then allowed to stand. This rate of settle will vary with different clays and different chemicals. For this shale one-minute readings were found convenient and desirable. A blank test with distilled water was run.

Brick Test The shale selected at this plant had been ground to pass a 12-mesh screen. It was mixed with a chemical solution of the desired strength by means of a spade in a wheel barrow and then fed into a small Mueller brick machine. After a definite amount of pugging, the clay was extruded through an end-cut brick die giving a column of clay about 4 in. wide and $2^3/_8$ in. deep.

For color and texture study, 4- by 4- by $^1/_2$-in. tile were cut by a wire drawn tightly across the face of the die and column.

Bars 1 by 1 by 7 inches were made in a die one inch square. The per cent water of plasticity, modulus of rupture (dry and fired), and absorption tests were run on these bars.

Results

The results of the tests are shown in Tables I and II. The column headed "Time (min.) 18-cc. vol. settle" represents the standard for the settle test. The standard, 18 cc., was taken because the 10 g. of shale finally settled approximately to this volume. Some would settle ultimately to a slightly smaller volume and some did not reach the 18-cc. volume, indicating that they were exceptionally slow in settling out.

The member marked "Blue shale" occurs just below the green shale and is merely given for comparison. The green shale is the one actually used in production at the plant for which this work was done and is the shale upon which the chemical treatments were made.

All of the solutions used in chemical treatment of the shale were made up as per cent by weight of pug water. The only exception to this was bentonite which was added (per cent by weight of pug water) dry to shale and then thoroughly mixed, after which distilled water was used to temper this mixture in pugging.

It was not possible to get all of the 1% $BaCO_3$ and $^1/_4$% $BaCO_3$ in solution at ordinary laboratory temperatures (70°F). The salt was accordingly added as a suspension. The barium, no doubt, accounts for the exceptionally fine color developed in these members.

TABLE II

Member	Time (min.) 18-cc. vol. settle	Working properties	Water of plasticity	Dry shrinkage	Fired shrinkage (cone 5)	Modulus of rupture		Absorption	Firing condition
						Dry	Increase (%)	Fired (cone 5)	
Green shale alone (28 mesh) aged 1 week		Fair strength and machining improved	23.98	3.30	4.47	348	75.7+	5674	4.26	Fair color; fine texture; some evidence of scumming
Green shale alone (28-mesh) aged 2 weeks		Good strength; improved plasticity and machining	22.51	3.27	7.95	329	66.1+	5655	2.03	Fine texture; color light; considerable scumming
2% molasses	10	Fair strength and plasticity	18.87	2.70	7.44	412	108.0+	4318	4.17	Color fine; texture fine; practically no scumming
2% molasses aged 1 week		Good strength and plasticity; machined well	18.88	2.25	7.43	380	92.0+	4511	3.32	Color fair; texture good; some scumming
2% molasses, aged 2 weeks		Fine strength and plasticity; machined well	21.10	2.79	7.91	416	110.0+	4482	2.57	Color fair; texture good; considerable scumming
4% H_2SO_4	36	Good strength fine plasticity	19.46	2.06	8.01	440	122.0+	4516	3.07	Color fair; texture good; a little scumming
1% $BaCO_3$	31	Poor strength and plasticity	20.08	2.01	7.65	289	45.9+	4379	2.58	Good color and texture; no scumming
1/4% $BaCO_3$	22	Poor strength and plasticity	20.79	3.01	8.09	273	37.9+	4063	2.39	Good color and texture; no scumming
1 1/4% alum	14	Fair plasticity and strength	22.01	2.61	7.08	290	46.5+	3975	4.97	Color fair; texture good; a little scumming

The member, "Green shale alone 12-mesh," is used as a basis for figuring the percentage change in dry modulus of rupture. The + indicates increase in dry modulus, while the − indicates decrease in modulus of rupture.

Discussion

The solution giving the most rapid settle was 2% molasses. The solution taking the greatest time to settle was 10% H_2SO_4.

The water required for proper pugging consistency varied with the electrolyte and its concentration. This variation was 17.75% for tannic acid to 22.01% for alum solution. The untreated shales (12-mesh) averaged about 19%.

The drying shrinkage varied from 1.01% for the untreated shale to 3.14% for the 1/4% glutrin solution. The average drying shrinkage was 2.3%.

The dry modulus of rupture varied from 696 lbs. per sq. in. for shale pugged with 10% H_2SO_4, giving an increase of 251% over the untreated shale which showed a modulus of rupture of 198 lbs. per sq. in.

Conclusions

(1) The settle test was of little value in giving a possible indication of what effect a certain chemical solution may have on the green or dry strength of the shale. This, it must be noted, was only used on one particular shale; if used on several types of clays or shales perhaps some conclusions could be drawn.

(2) Sulphuric acid increased the dry modulus of rupture 251% (10% H_2SO_4) and 122% (4% H_2SO_4) and also improved the machining and green strength of the shale. This benefit was offset by a deadening or leaching effect on the color of the finished or fired product.

(3) Organic binders such as Bindex and glutrin increased the dry modulus up to and exceeding 100%, but did not improve the machining and green strength of the shale.

(4) Molasses plus yeast improved the dry modulus considerably and also improved the machining and green strength. This was more marked when the batch was aged two weeks, apparently aiding bacterial growth.

(5) A solution of 1 to 2% Na_2CO_3 increased the dry modulus about 60%, but did not improve machining and green strength to a marked degree.

(6) 1% $BaCO_3$ increased the dry modulus about 45% and aided or improved the color of the fired product considerably. It did not improve machining or green strength a great deal.

(7) 2% bentonite increased the dry modulus about 45% and seemed to improve the plasticity, especially on repeated puggings.

(8) 1/4% HCl increased the dry modulus of rupture about 42%, but did not aid the machining and green strength materially. HCl did not show the leaching effect on the color that H_2SO_4 did.

(9) 1/4% tannic acid increased the dry modulus by 72% and helped the machining and green strength some. The high price of the chemical makes its use practically prohibitive.

(10) The various types of chemicals used showed no abnormal effect on the physical properties of the shale, when used in small concentrations.

(11) Grinding the shale to pass a 28-mesh screen and aging for one week gave an increase in dry modulus of 75.7% and also improved the machining and plasticity. Finer grinding and aging seem to be the most practical expedients in giving increased strength and machining properties.

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THE RELATION OF BRINELL HARDNESS AND TRANSVERSE STRENGTH TO THE COMPRESSIVE STRENGTH OF BUILDING BRICK[1]

By J. W. McBurney[2]

ABSTRACT

This paper reports the results of Brinell hardness determinations on twenty-five makes of brick together with their transverse and flat compressive strengths. These data indicate that though there is somewhat better correlation between Brinell numbers and flat compressive strength than exists between transverse strength and flat compressive strength, yet the relation is not sufficiently exact to permit the accurate estimation of flat compressive strength from a measured Brinell number.

I. Introduction

The proviso that "all brick shall be hard and well-fired" is of frequent occurrence in architects' specifications. It is suspected, however, that a considerable difference in opinion would arise if the criterion of "hardness" were to be defined. The term "hardness" is capable of a number of interpretations, as was pointed out by Tuckerman.[3] By "hardness" of a brick do we mean resistance to abrasion, ability to withstand shock, ability to scratch another body, high compressive strength, or what? Furthermore, used by itself, the word "hard" is necessarily relative. It is true that the present Federal Specifications Board, Specification No. 504, for brick (common) uses the terms "hard" and "soft" as names of grades defined by values for water absorption and transverse strength. The fact remains, that the clause "the brick shall be hard and well fired" is without quantitative significance.

The purpose of the present paper is not, however, that of providing a measure of hardness *per se* but is restricted to the question of the degree of correlation existing between the Brinell ball test and test of compressive and transverse strengths on the same specimens.

II. The Brinell Ball Test for Brick

Briefly described, the Brinell test for metals consists in indenting the surface of the material being tested by a hardened steel ball of standard diameter, under a standard load, and for a standard length of time, and then measuring the diameter of the projection of the indentation on the

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division). Received June 23, 1930.

[2] Research Associate, Common Brick Manufacturers Assn. of America at the National Bureau of Standards.

[3] L. B. Tuckerman, "Hardness and Hardness Testing," *Mech. Eng.*, **47**, pp. 47–53 (1925).

surface. This test, originally developed and standardized for use on metals, was first applied to ceramic materials by Le Chatelier and Bogitch.[4] They overcame the difficulty of determining the diameter of the indentation by interposing a sheet of copper foil, blackened by immersion in an aqueous solution of ammonium sulphide, between the steel ball and the surface of the material tested. Kreüger[5] also used the Brinell ball for determining the hardness of brick. Kreüger did not measure the diameter of the indentation, but instead estimated the depth by measuring the displacement of the ball in the direction of the applied force.

The technique used in making the tests reported in the present paper was essentially that of Le Chatelier and Bogitch. An area of one or two square centimeters on the brick surface selected for test was smoothed by grinding. On this smoothed area was laid a strip of copper foil, 0.08 mm. thick, which had been previously blackened by washing with an aqueous solution of ammonium sulphide. A constant load of 500 kg. for a period of one minute was applied to the copper foil, acting through a steel ball, 17.5 mm. ($^{11}/_{16}$ in.) in diameter. The diameter of the indentation, registered on the copper foil, was measured with a micrometer microscope to the nearest 0.1 millimeter.

III. Source of Data

Determinations of the Brinell hardness were made on certain of the samples, the transverse and compressive strengths of which were reported in a previous paper.[6] The reader is referred to that paper for a description of these samples. The sample numbers in that and the present paper refer to the same makes of brick.

Table I gives the average, maximum, and minimum diameters of the indentations for each of the samples tested. It will be noted that for sample No. 13A, the number of tests is three times the number of specimens. The reason for this is that the Brinell hardness was determined on the end, face, and flat surface of each of the brick forming sample 13A. All other specimens, except samples 14B and 16C, received two tests apiece, one each on the face and the flat. The specimens (one each) representing 14A and 16C split during the second test.

From the average diameter of indentation, the Brinell number is calculated and reported in Table I. The Brinell number is here defined as

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[4] H. Le Chatelier and B. Bogitch, "On the Employment of the Brinell Ball for Testing Construction Materials," *La Céramique*, **371**, 17–18 (1919).

[5] H. Kreüger, "Investigations on Climatic Action on the Exterior of Buildings," *Trans. Royal Swedish Inst. for Sci. Ind. Research*, No. 24, p. 103 (1923).

[6] J. W. McBurney, "The Compressive and Transverse Strength of Brick," *Jour. Amer. Ceram. Soc.*, **12** [4], 217 (1929); also Bur. Stand., *Jour. Research*, **2** [4], 821 (1929).

TABLE I

BRINELL BALL HARDNESS AND STRENGTH OF BRICK

Sample no.	No. of specimens	No. of tests	Diam. of indentation in 10^{-1} mm.			Brinell number load/area (av.)	Strength	
			Av.	Max.	Min.		Compression half flat (lbs./sq. in.)	Modulus of rupture (lbs./sq. in.)
2A	3	6	71	77	65	12.45	3520	800
6	3	6	71	78	65	12.45	3320	670
7	5	10	61	70	53	16.50	3110	489
8	3	6	73	75	70	11.35	3270	765
9	3	6	77	85	72	10.20	4215	730
10	1	2	46	48	45	29.40	7000	1170
11	1	2	72	78	65	11.80	3850	510
12	1	2	81	85	78	9.06	1990	500
13A	2	6	28	33	27	82.70	8610	1550
14A	3	6	59	90	40	17.85	3370	1320
14B	1	1	70			12.45	2840	490
16A	5	10	42	59	30	36.40	6710	947
16B	5	10	45	50	40	31.41	6550	1250
16C	1	1	80			9.37	2680	560
17A	5	10	36	49	30	47.85	10170	1573
18	6	12	33	38	35	56.90	14100	2130
19B	5	10	26	30	21	71.00	13780	1234
21	5	10	25	34	20	99.20	22600	2840
22A	5	10	50	64	40	24.60	5950	1864
22B	5	10	50	58	39	24.60	4040	1170
24A	3	6	25	28	22	99.20	21200	3230
24B	4	8	46	56	32	29.40	6250	987
25	1	2	40	42	37	39.50	7940	1320
26	1	2	35	35	35	52.00	6570	1020
27	1	2	54	58	51	21.10	3270	790

the load per unit of spherical surface of contact and is calculated from the formula

$$B = \frac{W}{2\pi r\left[r - \sqrt{r^2 - \left(\frac{D}{2}\right)^2}\right]}$$

Where B = Brinell number
W = load (500 kg.)
r = radius of ball in mm. (8.75)
D = diameter of indentation in mm.

The results of the tests of strength (compressive, half-brick flatwise, and transverse) on the same specimens that were tested for Brinell hardness are also included in Table I.

IV. Discussion of Results

Figure 1 presents the data of Table I according to the following plan. The abscissa represents compressive strength. Two ordinates, one for the transverse strength and the other for the Brinell number are used. These two ordinates or scales are related as follows:

The various Brinell numbers were multiplied by the factor 34.47, which factor was obtained by dividing the mean of the transverse strengths, 1196, by the mean of the Brinell numbers, 34.7. Assigning the numerical value 200 to one division of the ordinate for transverse strength, the values for the Brinell numbers multiplied by 34.47 were plotted to the same scale. The corresponding original numerical values of the Brinell numbers are indicated on the ordinate to the right. The advantage of this method of plotting is that the values of transverse strength and Brinell number are made to occupy the same range and hence, if there were a

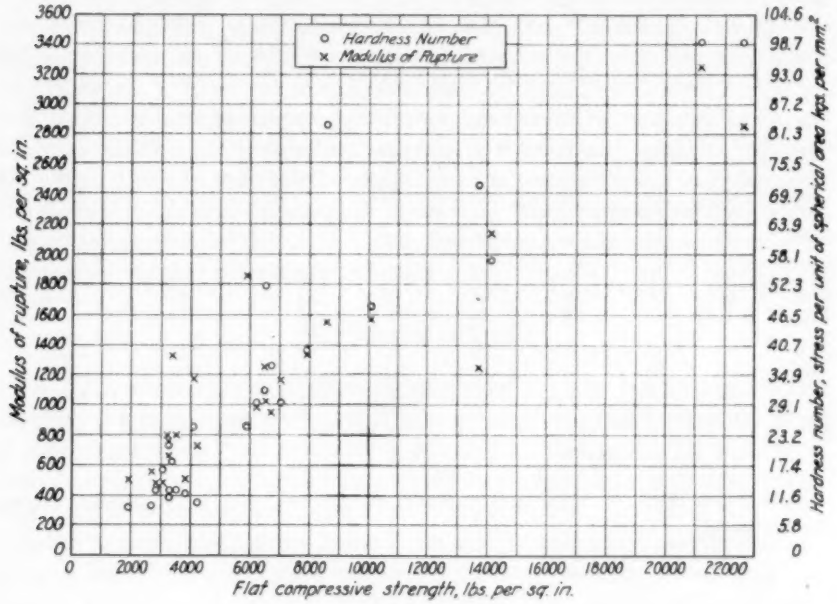

FIG. 1.

more pronounced scattering of the values for one than for the other, it would be apparent at a glance.

If it be assumed that the most probable relation between Brinell number and corresponding flat compressive strength is represented by a straight line passing through the origin and through the point represented by the mean of the Brinell numbers and the mean of the flat compressive strengths and if a similar assumption be made for the relation between transverse strength and flat compressive strength then this method of plotting would result in the coincidence of these two straight lines.

In Fig. 1, the circles represent the (Brinell number, compressive strength) relations and the crosses, the corresponding (transverse strength, compressive strength) relations.

It is evident from an inspection of Fig. 1 that considerable deviation from this assumed linear relationship to compressive strengths exists for both the transverse strengths and the Brinell numbers. Calculating the coefficients of correlation[7] for these relationships the coefficient of correlation for the (Brinell number, compressive strength) relation is 0.924 and the coefficient of correlation for the (transverse strength, compressive strength) relation is 0.905. These values are calculated from the data given in Table I. It will be remembered that the coefficient of correlation is a number which may have any value between +1 or −1, inclusive. A value of +1 represents perfect correlation, such as would be found to exist between absolutely accurate reading of a Fahrenheit and a centigrade thermometer. A value of −1 represents perfect recipro-

TABLE II

OBSERVED AND CALCULATED COMPRESSIVE STRENGTHS

Sample no.	Flat compressive strength observed (lbs./sq. in.)	Flat compressive strength calculated from Brinell numbers (lbs./sq. in.)	Deviation from observed compressive strength (lbs./sq. in.)	Flat compressive strength calculated from modulus of rupture (lbs./sq. in.)	Deviation from observed compressive strength (lbs./sq. in.)
2A	3520	2984	− 536	4281	+ 761
6	3320	2984	− 336	3364	+ 44
7	3110	3727	+ 617	2088	−1022
8	3270	2782	− 488	4034	+ 764
9	4215	2571	−1644	3787	− 428
10	7000	6095	− 905	6890	− 110
11	3850	2865	− 985	2236	−1614
12	1990	2362	+ 372	2165	+ 175
13A	8610	15875	+7265	9569	+ 959
14A	3370	3975	+ 605	7947	+4577
14B	2840	2984	+ 144	2095	− 745
16A	6710	7379	+ 669	5317	−1393
16B	6550	6463	− 87	7454	+ 904
16C	2680	2419	− 261	2588	− 92
17A	10170	9480	− 690	9731	− 439
18	14100	11141	−2959	13659	− 441
19B	13780	13728	− 52	7341	−6439
21	22600	18903	−3697	18665	−3935
22A	5950	5214	− 736	11783	+5893
22B	4040	5214	+1174	6890	+2850
24A	21200	18903	−2297	21405	− 205
24B	6250	6094	− 156	5599	− 651
25	7940	7948	+ 8	7987	+ 47
26	6570	10242	+3672	5832	− 738
27	3270	4571	+1301	4210	+ 940
Mean	7076	7076		7076	
Mean deviation			1266		1447
MD/M			0.179		0.204
Standard deviation	5389		2046		2301
Std. D/M (coefficient of variation)			0.289		0.325

[7] See A. E. R. Westman's "Statistical Methods in Ceramic Research," *Jour. Amer. Ceram. Soc.*, **10** [3], 133–47 (1927), or any of the standard books on statistics such as G. U. Yule's or R. A. Fisher's.

cal correlation, such as exists between the pressure and volume of a perfect gas when the temperature is held constant. A correlation coefficient of zero means a total lack of correlation. In other words, the pairs of values show but chance, random relations to each other, as, for example, the correlation between the appearance of the same face in repeated throws of two dice or two coins.

From the values of these correlation coefficients and from the appearance of Fig. 1 it can be said that there is little choice between the Brinell number and the transverse strength as a measure of the flat compressive strength of a brick. Notwithstanding these relatively high coefficients of correlation, quite large deviations are found when the experimental compressive strengths are compared with the calculated values from either the Brinell number or the modulus of rupture. It should be emphasized that the coefficient of correlation is not a linear measure of "goodness of fit" of experimental and calculated values where "goodness of fit" is measured by the minimization of the standard deviations of the observed compressive strengths from values calculated from the other measures of strength.

Table II presents the compressive strengths calculated from the Brinell numbers and from the moduli of rupture. The (compressive strength, Brinell number) relation was taken to be the following:

$$C = 699.6 + 183.5B$$

Where C = calculated compressive strength
B = observed Brinell number.

Correspondingly,

$$C = -1365 + 7.051M$$

Where M = observed modulus of rupture.

These constants were computed by the method of least squares. It will be noted that some of the deviation of the calculated from the observed values are of considerable magnitude.

Calculating the coefficient of alienation, k, from the coefficient of correlation of the (Brinell number, compressive strength) relation by the formula,

$$k = \sqrt{1-r^2}$$

where r = coefficient of correlation (0.9242) and
$k = 0.382$.

The corresponding value of k for the (transverse strength, compressive strength) relation is 0.425. This can be interpreted as meaning that the error of estimating a compressive strength from a known Brinell number is 38.2% of the error of estimation when the compressive strength is a shear guess within the original distribution. Correspondingly, the error of estimate of a given compressive strength from a determination of trans-

verse strength is 42.5% of the error if there were only a random relation. Numerically these values are nearly those obtained by dividing the standard deviations of the deviations of the calculated compressive strengths from the observed compressive strength by the standard deviation of the observed compressive strength.

It should be evident from Table II that if any very accurate estimate of the compressive strength of a given make of brick is desired, the determination of neither the Brinell hardness nor the transverse strength will serve.

The foregoing statement applies to the examination of random makes

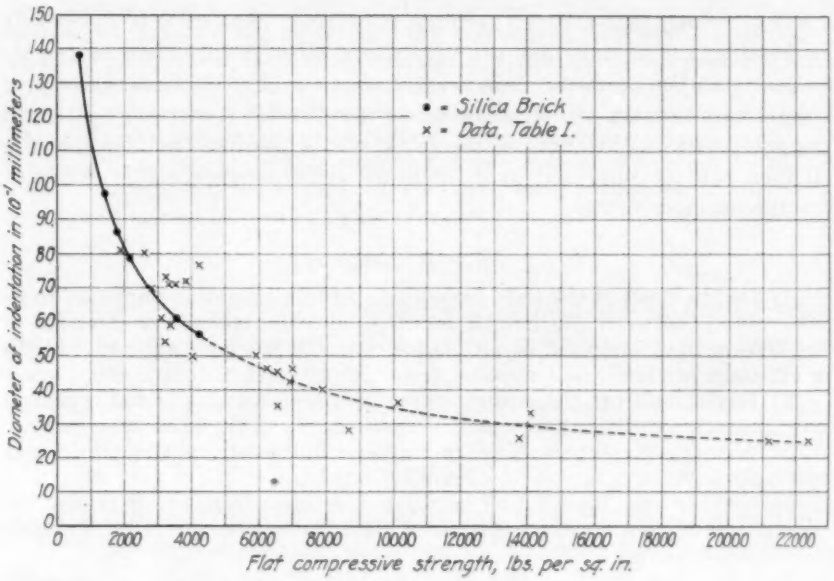

FIG. 2.

of brick, differing in method of manufacture and in raw materials. For the product of a given plant and where the comparison is confined to that plant's output, both the Brinell number and the modulus of rupture should provide relative measures sufficiently accurate for the estimation of compressive strength, possibly within the range of variability of that property, usually characteristic of such materials.

V. The Limitations of the Brinell Ball Test

Obviously the Brinell ball test measures the hardness of the portion of the brick in the region of contact with the ball. Hence this test would fail to measure properly the strength of a nonhomogeneous brick. Sam-

ple 13A is a case in point. The brick represented by 13A has a core[8] which is evidently weaker than the shell of the brick.

Sample No. 14A represents a highly laminated end-cut brick. The diameter of the indentation for the side of the brick was 4.0 mm. and for the flat, 9.0 mm. The average Brinell number, 17.85 kg./mm.^{2} (corresponding to an indentation of 5.9 mm.), for this sample is in fair accord with the flat compressive strength of this make of brick.

Figure 2 presents graphically the relation between the diameter of indentation and the flat compressive strength of the samples tested. In addition to the data from Table I, Fig. 2 uses data on silica brick presented in a circular[9] describing the patented equipment of R. Guillery used in making Brinell ball tests on ceramic material. The curve is hyperbolic in form and assuming that the percentage error in measurement varies inversely as the diameter, it is evident that the degree of uncertainty of the relation between the Brinell number and the flat compressive strength increases with the strength of the brick. It is possible that the use of a smaller ball, or increased load, or both would overcome this difficulty for the stronger brick.

VI. Conclusions

(1) On the basis of the data presented in this paper, there appears to be little choice between the Brinell hardness and the transverse strength of brick from the standpoint of correlation with the flat compressive strength of the same brick.

(2) Deviation from the mean relation of Brinell number to flat compressive strength is explainable by lack of homogeneity of the brick specimens.

(3) With the pressure and size of ball used in these tests, the Brinell ball test lacks sensitivity for brick of high strength.

(4) Neither the Brinell ball test nor the measurement of transverse strength permits a close estimation of the compressive strength of a particular brick sample.

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[8] J. W. McBurney, "The Compressive and Transverse Strength of Brick," *Jour. Amer. Ceram. Soc.*, **12** [4], 217 (1929).

[9] "Apparatus for Testing Building Materials (in particular bricks) by the Brinell Method," System, R. Guillery; process, Le Chatelier and Bogitch; makers, "Société des Établissements Malicit & Blin."

FORMING PRESSURE OF DRY-PRESSED REFRACTORIES. II. THE EFFECT OF PRESSURE VARIATIONS ON FIRED PROPERTIES[1]

By Raymond E. Birch[2]

ABSTRACT

Laboratory tests of the dry-pressed fire brick revealt hat fired porosity varies inversely with the forming pressure. The change, however, is less marked at high pressures. The resistance to thermal spalling is considerably lowered by increased pressure. The course of spalling is traced for brick of various pressure and density. The relative importance of the various factors affecting spalling loss is discussed. In regard to the load test, increased pressure results in marked improvement with the highly plastic mixtures and more indifferent results when much flint clay is present. In general, firing shrinkage is increased by increased forming pressure, the phenomenon being explained as due to improved continuity of the material tending to further the pyrochemical reactions. The comparatively low pressures of mechanical presses are reaffirmed by a study of fired properties. A summary of the data indicates that by utilizing higher pressures, brick of greater density may be obtained which are greatly improved in appearance, in resistance to abrasion, and in load-carrying capacity, but with diminished resistance to thermal shock. It is indicated that higher forming pressures would partially obviate the necessity of firing ware to the present high temperatures.

Introduction

The earlier paper (Part I)[3] reported data obtained on unfired brick formed at various pressures. The present paper reports the results of tests applied to the fired brick, to determine the effects of changes of forming pressure on the properties that affect the behavior of refractories in service.

Procedure

Firing Unfired experimental brick were taken to the plants from which the clay batches were obtained and there fired. They were then returned to the Station for the physical tests. Brick made at each of the plants were pressed with two different moisture contents, fired with the laboratory brick, and brought to the laboratory for testing.

Spalling Five brick of each pressure series were subjected to a two-inch water immersion spalling test, corresponding (with certain modifications) to the one-time A.S.T.M. tentative standard (C38–27T) and test No. 63 of the American Ceramic Society.[4] The test was

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Refractories Division). Received June 25, 1930.

[2] Research Engineer, O. S. U. Engineering Experiment Station, Clay Products Plant, Roseville, Ohio.

[3] R. E. Birch, "Forming Pressure of Dry-Pressed Refractories, Part I," *Jour. Amer. Ceram. Soc.*, **13** [4], 242 (1930).

[4] *Jour. Amer. Ceram. Soc.*, **11** [6], 461 (1928).

terminated at the end of ten immersions or previously if each brick of a series had suffered a loss of 20% by weight.

Load Test The AMERICAN CERAMIC SOCIETY standard load test (A.S.T.M. C16-20) for high-heat duty fireclay brick was applied to two brick of each series, noting the total deformation and, with the two mixtures of low refractoriness (A and H), the temperature of failure.

Slag Erosion Brick of two additional refractory mixtures, formed at 800, 2000, and 5000 lbs. per sq. in. were submitted to slag erosion tests in the rotary furnace used by the University of Illinois, Engineering Experiment Station in conjunction with the A.S.M.E. in its work on slag erosion. One mixture was composed of 60% flint fire clay and 40% plastic fire clay, while the other contained only 20% flint fire clay. Their pyrometric cone equivalents were 31 to 32 and 28, respectively. The slag was composed of equal parts of Vermillion County, Ill., coal and coal ash. Tests were run at average temperatures of 2710°F and 2788°F. Samples of a Missouri high alumina brick and a Missouri high flint clay brick were included in the furnace with the test brick. The last brick, referred to as brand 18, has been used in nearly all the slag erosion work at the University of Illinois, to supply fixed reference data. The furnace and similar tests have been described by Hursh and Grigsby.[5]

Crushing Tests Brick of the same two mixtures as those which were submitted to the slag tests were formed at each pressure and the crushing strength was determined. The capping mixture was sulphur and silica sand as recommended by Mitra.[6]

Abrasion Test The abrasion resistance of the refractories was tested with an apparatus which followed that described by Harvey and McGee.[7] The test specimen mounted flat on the body of a carriage runs under an abrasive wheel so that a groove $1/4$ inch deep is cut in the brick. The length of cut produced in a given time is taken as a measure of resistance to abrasion. The carriage is propelled by a ten-pound weight suspended over a pulley at the end of the table. The tracks are 2- by 2-inch steel angle sections. The abrasive wheel (silicon carbide) is six inches in diameter and has a half-inch cutting face. It is direct mounted on a 5 H.P. alternating current motor, with a speed of 1800 r.p.m.

Before taking any data, a groove about $1\frac{1}{2}$ inches long was cut into the brick so that the wheel could act against a constant amount of surface

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[5] R. K. Hursh and C. E. Grigsby, "A Laboratory Furnace for Testing Resistance of Fire Brick to Slag Erosion," Univ. of Ill., Eng. Expt. Sta., *Circ.*, No. 17.

[6] H. K. Mitra, "Cold Crushing Strength of Fire Brick," *Jour. Amer. Ceram. Soc.*, **13** [2], 85 (1930) and O. S. U., Eng. Expt. Sta., *Bull.*, No. 54, p. 3.

[7] Fred A. Harvey and E. N. McGee, "Factors Affecting the Resistance of Silica Refractories to Abrasion," *Jour. Amer. Ceram. Soc.*, **7** [12], 895–906 (1924).

throughout the test. This starting point was marked on the brick. A stop-watch was used to measure the time of test. Since the brick covered a wide range of hardness it was not possible to standardize on any certain time for the test. It varied from a few seconds for soft brick to about two minutes for very hard ware. The length of cut was measured and the time which would be required to produce a 9-inch cut was then computed. Two tests were made on each brick at atmospheric temperature.

Results

Fired Porosity The fired porosity of the test brick varied inversely with the forming pressure, although the change for any increment of pressure was much less at the higher forming pressures.

TABLE I

Product no.	Total tons	Lbs./-sq. in.	Fired porosity* A	B	C	D	E	F	G	H
1			22.97	24.06	24.89	25.54	22.86	18.41		18.80
2			15.63		25.28	25.26	25.86	17.75		17.36
3	12	530	24.74	24.00	27.66	26.15	24.56		27.74	19.90
4	20	885	22.50	21.71	23.77	22.77	20.77	19.32	26.17	18.05
5	35	1550	18.73		20.05	20.37	17.52	15.88	23.82	14.88
6	80	3545	15.29	20.15	16.48	18.39	13.53	15.85	20.01	12.25
7	125	5540	14.90	19.43	15.80	16.41	12.45	16.55	19.20	

* In air-expansion porosimeter. For body compositions, see Part I, *loc. cit.*
1 = regular plant product.
2 = brick pressed at plant of laboratory batches.
3, 4, 5, 6, and 7 = brick pressed at laboratory at pressures indicated.

The plastic clay mixtures had the greater decrease in porosity with pressure increase. Due to increasing the pressure from 530 to 5540 lbs. per sq. in., bodies A, C, D, and E averaged a porosity decrease of 10.89%, while the four less plastic mixtures decreased only 6.06% (see Fig. 1 and Table I).

The bodies that were low in plastic clays gave irregular results. For

TABLE II

FORMING PRESSURE VS. DRYING AND FIRING SHRINKAGE

Forming pressure: Total tons	Lbs./-sq. in.	Body notation: A	B	C	D	E	F	G	H
		Linear drying shrinkage (green length %)							
12	530	0.32	0.53	0.31	0.32	0.32	0.32		
20	885	0.21	0.32	0.32	0.32	0.16	0.16	−0.01	
35	1550	0.32	0.32	0.32	0.32	0.32	0.16		
80	3545	0.16	0.32	0.21	0.16		0.16	−0.01	
125	5540	0.16	0.42	0.32	0.16		0.16	−0.01	
		Linear firing shrinkage (dry length %)							
12	530	0.41	2.01	3.38	1.48	4.41		0.52	2.94
20	885	0.45	2.96	3.70	1.48	4.69	3.80	0.73	2.74
35	1550	1.00		3.70	1.48	4.55	3.95	0.73	2.74
80	3545	1.32	2.98	3.90	1.63	4.94	3.84	0.84	2.74
125	5540	1.38	2.89	3.80	1.63	4.94	3.80	1.05	

instance, B and F, which conformed to the general trends least of all, did not increase appreciably in density at pressures higher than 3545 lbs. per sq. in. Using the high plastic clay bodies, the porosity change

TABLE III

RELATION OF FORMING PRESSURE TO SPALLING LOSS

(Percentage by Weight Loss at End of Test)

	Pressure (lbs./sq. in.)	Body notation A *	B	C ††	D	E	F **	G	H †
Regular body	?	19.2	8.6	3.8	7.4	3.8	2.6		..
Adjusted body	?	19.6		6.6	4.4	1.0	16.4	5.8	32.2
	530	21.8	5.4	7.2	12.2	4.4		5.2	27.6
	885	21.0	9.8	6.0	8.4	0.6	16.8	0.4	28.6
	1550	37.6		9.8	18.0	19.0	36.6	2.8	31.6
	3545	28.0	6.2	12.8	22.5	31.6	31.6	6.8	
	5540	39.6	14.6	25.8	13.2		37.2	11.5	

* Body A, 5 immersions only. †† Body C, 8 immersions only. ** Body F, 9 immersions only. † Body H, 7 immersions only.

occasioned by any given increase in pressure was so regular as to supply a rough basis for prediction of these results.

Drying and Firing Shrinkage Increase in forming pressure resulted in increased firing shrinkage with all but one body. The average increase in firing shrinkage due to change of forming

TABLE IV

SUBSIDENCE IN LOAD TEST

(Per Cent of Original Length)

Forming pressure Tons total	Lbs./sq. in.	Body notation A	B	C	D	E	F	G	H
12	530	1300°C*	1.1	7.7	8.9	7.6		3.8	45 min.†
		1340°C*	2.1	8.8	6.4	9.8		4.1	
30	885	25 min.†	3.5	4.6	7.4	6.7	7.6	0.9	45 min.†
		1340°		4.8	4.5	5.2	5.6	1.6	60 min.†
35	1550	35 min.†		4.8	3.9	2.0	6.3	1.1	5.1
		16.5		2.7	3.4	1.1	6.6	2.8	
80	3545	40 min.†	1.1	2.8	4.4	2.0	2.5	0.3	
		11.6	0.8	3.0	3.0	4.2	4.5	2.4	
125	5540	12.7	3.6	3.3	3.0	2.0	7.0	4.2	
		9.2	3.4	2.1	4.2	3.7	3.2	4.2	
Plant brick		30 min.†	2.0	7.9	3.9	8.5	8.3	1.3	25 min.†
Adjusted H_2O			5.5	6.7	5.8	7.3	2.8	2.4	45 min.†
Plant brick		1350°*	2.0	4.6	8.7	7.5	3.6		45 min.†
Regular H_2O		1350°*	5.5	6.1	6.3	6.9	4.8		60 min.†

* Temperature at failure.
† Time at 1350°C before failure.

pressure from 530 to 885 lbs. per sq. in. was 0.31%. Except with bodies A and G, further pressure increase had little effect. Body H was the only one in which the firing shrinkage did not increase with increase in forming pressure, due doubtlessly to its high quartz content.

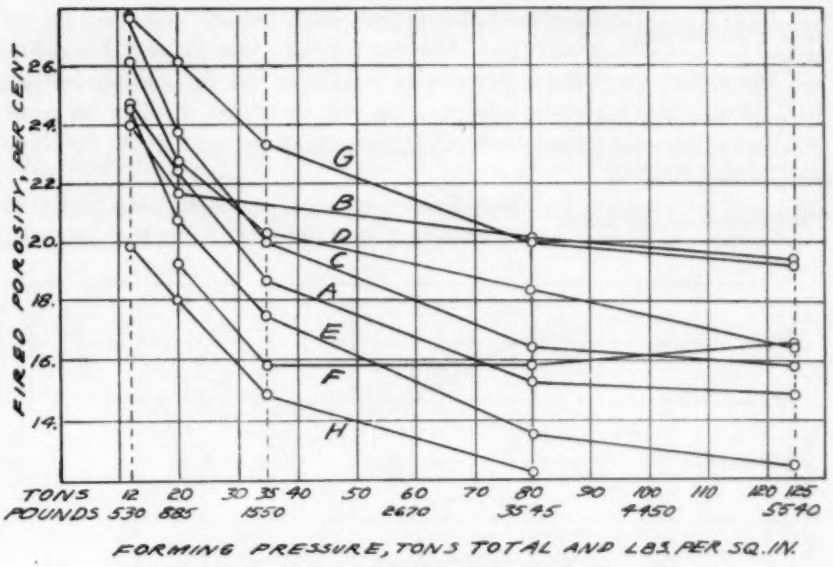

FIG. 1.—The relation of forming pressure to fired porosity.

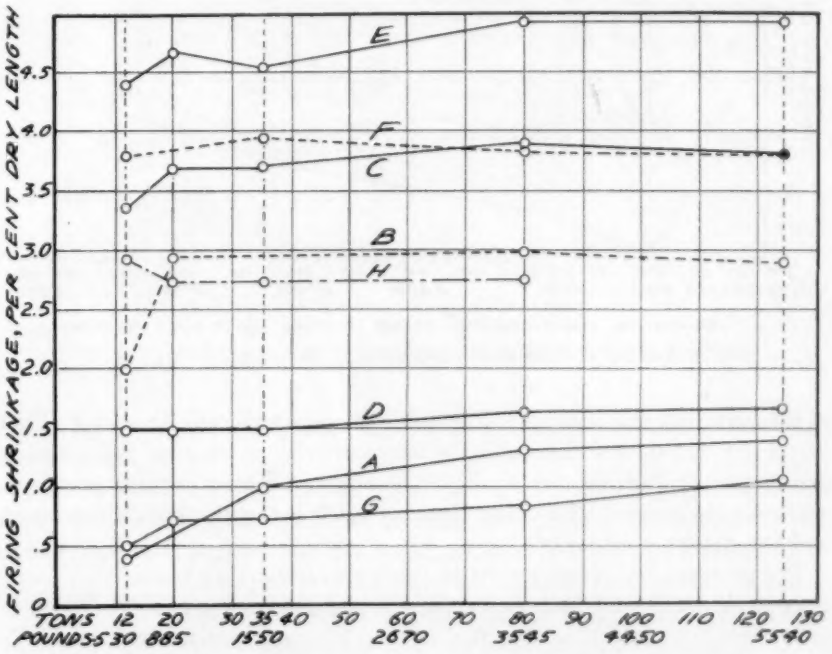

FIG. 2.—The relation of forming pressure to linear firing shrinkage.

Thermal Spalling Thermal spalling was considerably increased by increasing the forming pressure (see Table III and Fig. 3). Increasing the forming pressure from 530 to 885 lbs. per sq. in. had little effect, but higher pressures produced increased spalling in most cases. In general, increased spalling was most marked with the high plastic clay bodies.

Subsidence under Load The behavior of the high plastic clay bodies in the load test was different from the behavior

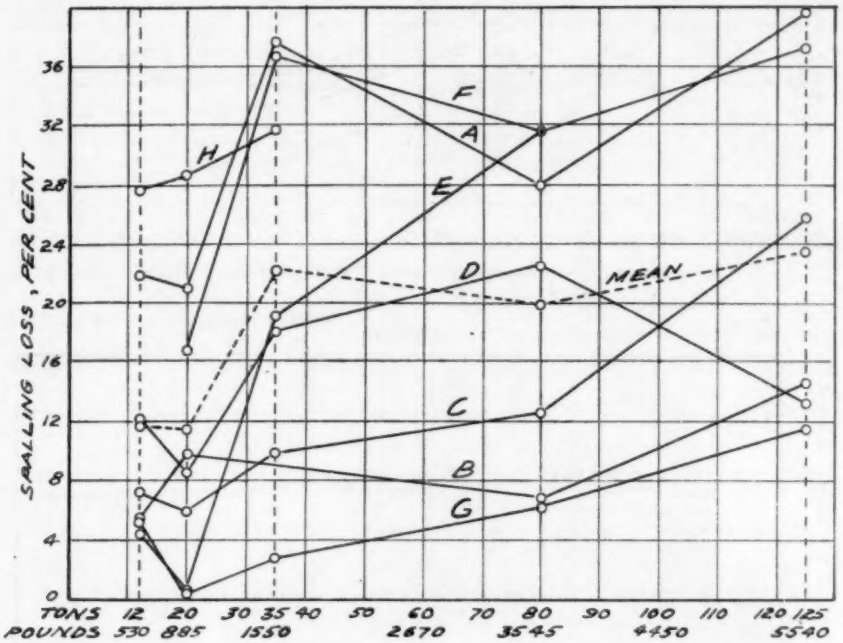

FIG. 3.—The relation of forming pressure to loss in spalling test.

of the high flint clay bodies. The subsidence of bodies C, D, and E (high in plastic clays) was progressively decreased by increasing the forming pressure up to 1550 lbs. per sq. in. The effect of higher forming pressures was less pronounced. The high flint clay brick were only slightly improved and the results were erratic.

The pronounced improvement in the high plastic clay bodies C, D, and E is shown in Fig. 4 and Table IV. Averaged results from the tests of mixtures D, C, and E at 530 lbs. per sq. in. gave a deformation of 8%, at 885 lbs., 6.4%, and only 3.7% at 1550 lbs. per sq. in. The average subsidence of plant-made brick from these three mixtures was 6.7%.

Bodies A and H (P.C.E. 19 and 26, respectively) failed by slumping in most instances, but the test brick formed at the highest pressures (5540 lbs. per sq. in. for mixture A and 1550 lbs. per sq. in. for H) did not fail.

Slag Erosion The slag erosion data (Table V) are given graphically in Figure 5.

The improvement of the brick formed at higher pressure reaffirms the belief that improvement for high slagging service conditions can be attained by structural changes in the body as well as by altering the chemical composition.

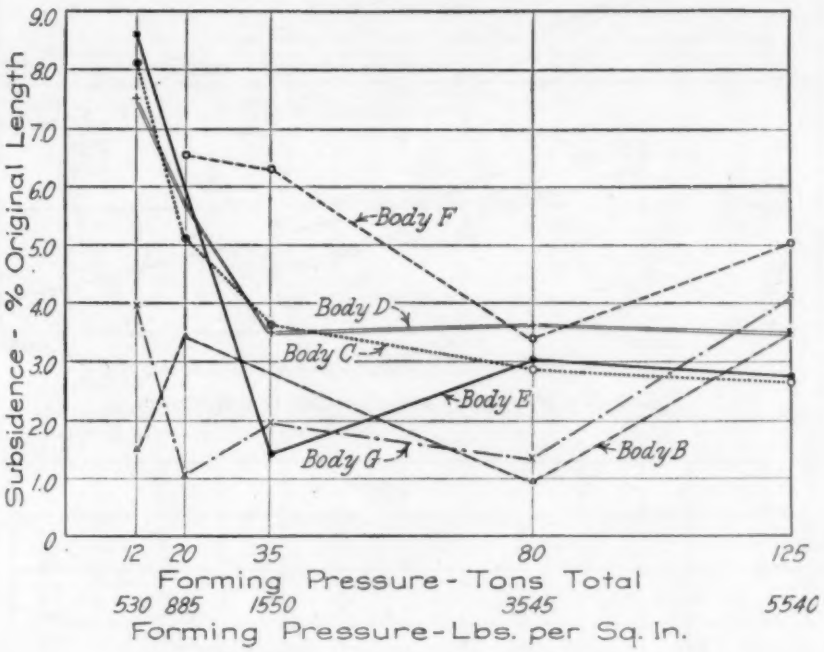

FIG. 4.—The relation of forming pressure to subsidence in the load test.

The Missouri brick is used as standard for comparison in all tests run at the University of Illinois. No conclusion regarding the relative merits of the two clay mixtures and the standard brands should be attempted.

Crushing Tests The two bodies tested gained greatly in crushing strength, due to increase in forming pressure (see Table VI). The increase in strength obtained by increasing the forming pressure from 800 to 5000 lbs. per sq. in. was 320% for the plastic clay body and 430% for the high flint clay mixture.

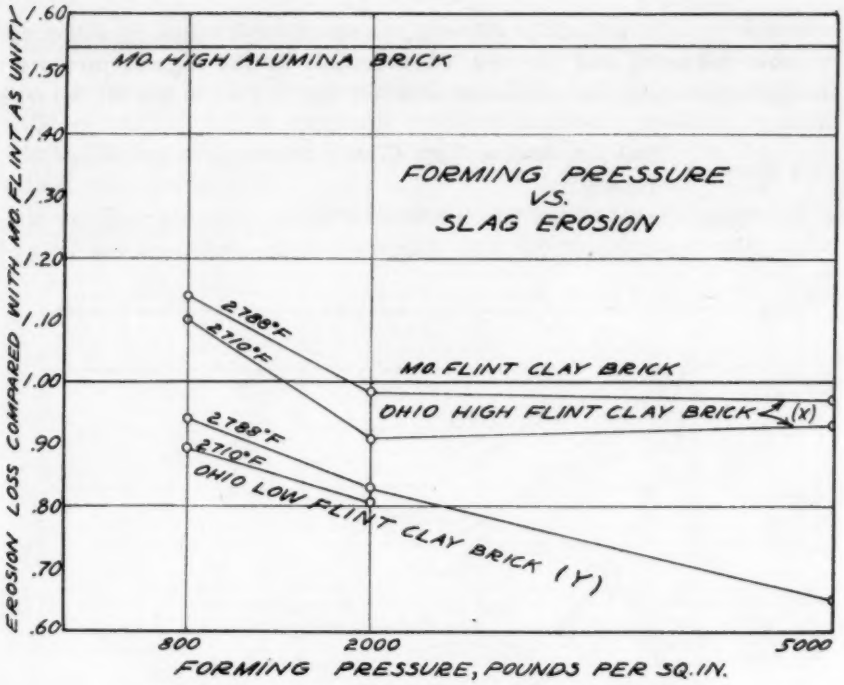

FIG. 5.—The relation of forming pressure to slag erosion.

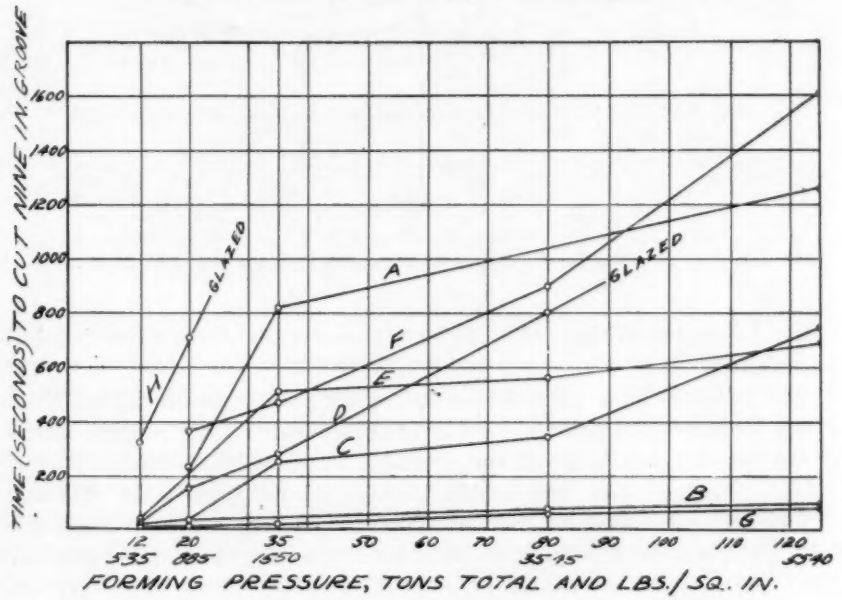

FIG. 6.—The relation of forming pressure to resistance to abrasion.

Abrasion Resistance The abrasion test results indicate a direct increase in resistance to abrasion, with increase in forming pressure. See Table VII and Fig. 6.

Plant Forming Pressures

Comparison of the green bulk density of the test brick with that of brick formed on mechanically actuated plant presses was made in Part I

TABLE V

SLAG TEST DATA

Forming pressure (lbs./sq. in.)	Average erosion loss (cu.cm./sq.cm.) Test 1 (2788°F)	Test 2 (2710°F)	Rating* by comparison with brand 18 Test 1 (2788°F)	Test 2 (2710°F)
	Mixture Containing 60% Flint Fire Clay			
800	1.17	0.77	1.14	1.10
2000	1.01	0.64	0.98	0.91
5000	1.00	0.65	0.97	0.93
	Mixture Containing 20% Flint Fire Clay			
800	0.97	0.94	0.63	0.89
2000	0.86	0.83	0.57	0.81
5000	0.67		0.65	
	Brand 18 (Mo. High Flint Clay Brick)			
Unknown	1.03	0.70	1.00	1.00
	Brand 17 (Mo. High Alumina Brick)			
Unknown		1.08		1.54

* Obtained by dividing the erosion in cu. cm. per sq. cm. of surface by the loss with brand 18 given in the same terms.

TABLE VI

END CRUSHING STRENGTH

Forming pressure (lbs./sq. in.)	Crushing strength (lbs./sq. in.) Mixture 40% plastic clay 60% flint fire clay	Mixture 80% plastic clay 20% flint fire clay
800	1400	2380
2000	4730	5860
5000	7480	10,100

TABLE VII

ABRASION RESISTANCE

Forming Pressure		Body notation							
		A	B	C	D	E	F	G	H
Total tons	Lbs./-sq. in.	Time in seconds required to cut a groove 9 inches long by 1/4 inch deep							
12	530		17.3	8.6	24.6	40.7		3.5	306.2
20	885	232.8		29.0	167.5		371.0	4.1	715.0
35	1550	822.0		277.0	285.9	519.0	472.0	9.6	Glazed
80	3545		81.3	354.0	802.5	568.0	911.0	67.3	Glazed
125	5540	1270.0	180.0	747.5	Glazed	697.0	1620.0	78.5	
Plant brick Regular mix		123.2		7.3	40.3	6.2			306.0
Plant brick Drier mix				8.4	21.1		115.0	6.5	

of this series of papers. It was assumed that a comparison of such pressure effects is a good indirect method of determining the plant pressures.

The plant-pressed brick were formed from a portion of the same clay batches used in the laboratory. The moisture content was the same. The green bulk density comparison is probably more reliable than the comparison of other physical properties, since the brick were examined

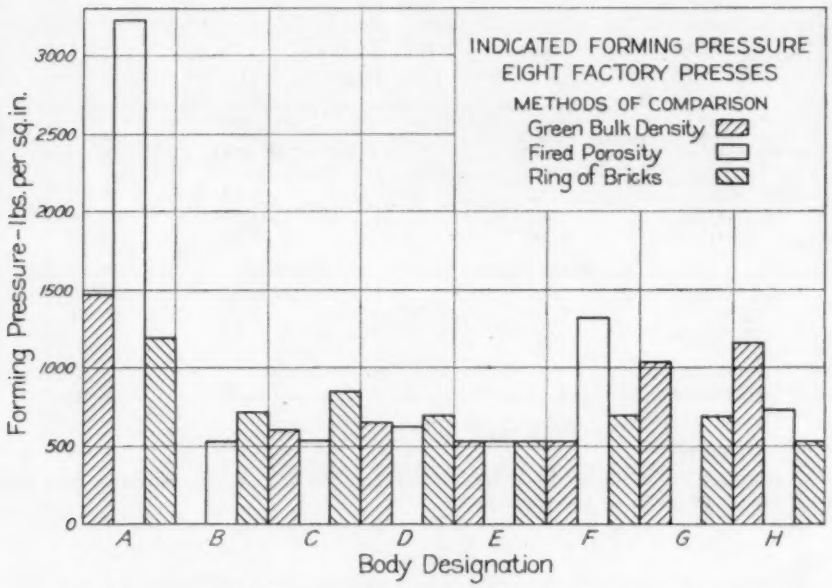

FIG. 7.—Commercial forming pressures indicated by comparisons of physical properties of plant brick and those formed from the same clay batches at known pressures on the hydraulic press.

fresh from the press. For affirmation, however, two other characteristics were compared with the following results:

(1) Fired Porosity Comparison of the fired porosity of brick is subject to variations resulting from unequal heat treatment, although efforts were made to minimize these errors. The fired porosity of the plant-pressed brick indicates industrial pressure varying from less than 530 to 3250 lbs. per sq. in. (in a single exceptional case). These data are given in Table VIII and are shown graphically in Fig. 7.

(2) Ring of Brick The pitch of the note sounded when a brick is struck with a steel rod is related to the forming pressure of the brick. The plant-pressed brick were readily located in each series and in general corresponded to the test brick formed at 530 to 1550 lbs. per sq. in. pressure.

Appearance and Defects The brick formed at 1550 lbs. per sq. in. and higher pressures appeared to be dense and of better mechanical strength than the plant brick. Their edges and corners are better preserved. The plant-pressed brick of body A as

TABLE VIII

PLANT FORMING PRESSURES (IN LBS./SQ. IN.) INDICATED BY COMPARISON OF PLANT BRICK WITH THOSE PRESSED AT KNOWN PRESSURES

Body notation	Method of comparison: Green bulk density	Fired porosity	Ring of brick
A	1470	3250	885–1550
B		530	530
C	610	710	885
D	650	620	530–885
E	<530	<530	530
F	<530	1355	530–885
G	1035		530–885
H	1150	740	<530

well as those formed experimentally at 530 and 885 lbs. per sq. in. are kiln marked. The imperfection is slightly visible in the 3545-pound series, and not at all at higher pressures.

Table IX indicates the development of laminations and pressure cracks in firing. In all cases the cracks paralleling the 9-inch dimensions were traceable to forming difficulties.

Interpretation of Data

Firing Shrinkage The observation that firing shrinkage increases directly with forming pressure has few precedents in ceramic research. Phelps noted this phenomenon, but was inclined to discount it.[8]

TABLE IX

DEVELOPMENT OF DEFECTS IN FIRING

Body	Green ware	Fired ware
A	No cracking	No cracking
B	Cracking 30–80 T	Cracking 30–80 T
C	No cracking	Checked along pressure cracking line in 80-T series
D	Cracking at 125 T only (avoided by heating clay)	Lamination in 80- and 125-T series; cracked at 125 T
E	Laminations in 80- and 125-T series	Laminated in 80- and 125-T series; end cracks in nearly all brick, unaccompanied by lamination and apparently not related to pressure cracks
F	Laminations in 80- and 125-T series	Pressure cracking in 80- and 125-T series
G	Slight pressure cracks at 125 T	Severe pressure cracking in 125-T series; occasional slight cracking at 80 T
H	Pressure cracking at 125 T (laminations at 80 T)	Pressure cracking at 125, 80, and 35 T

[8] S. M. Phelps, "The Effect of Water Content and Pressure of Repressing on the Porosity of Stiff-Mud Brick," A. R. I., *Tech. Bull.*, No. 11, May (1927).

Others[9] who have studied the effect of variant forming pressure on dry-press mixtures, without exception, have found the general trend to be a decrease in firing shrinkage with increase in forming pressure. Most of these previous investigations have been confined to tile bodies.

In the present case, the direct relation between firing shrinkage and forming pressure may be attributed to the improved facilities for fusion. The bodies are more continuous at higher forming pressure and the grains

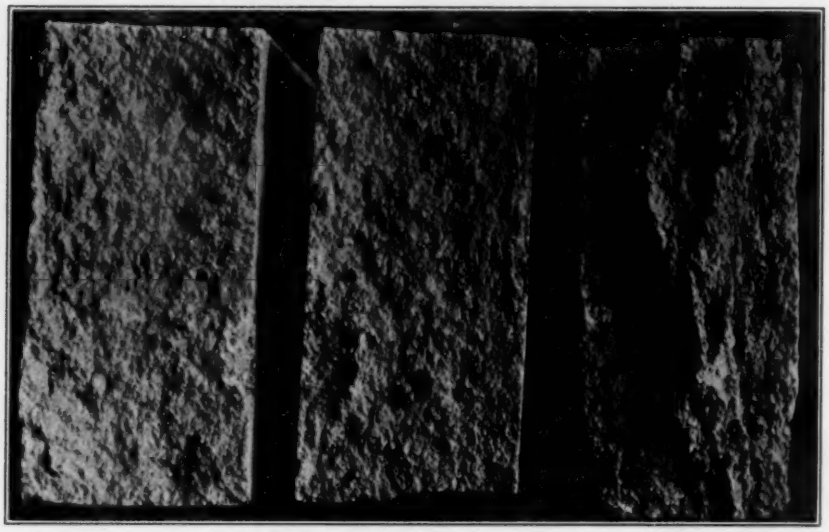

FIG. 8.—These three brick were pressed at 6000 lbs. per sq. in., the one on the right with the vacuum equipment in place but not being operated. The other two brick were pressed at reduced pressures, the middle one with 36 cms. of mercury, and the one on the left with only 16 cms. of mercury.

have greater contact areas. More glass is formed at any given temperature in the high-pressure brick.

Due to devitrification, it is impossible to determine the amount of glass developed in brick of different forming pressure. In those formed at higher pressures, however, the contact between plastic and flint clay is much more intimate. In many cases, contact appears perfect and there

[9] E. Watkin, "The Effect of Pressure on the Subsequent Contraction, Tensile Strength, and Crazing of Tiles," *Trans. Ceram. Soc.* [Eng.], **17,** 111 (1917).

F. W. Walker and E. G. Kerr, "The Effect of Variation in Pressure and Moisture upon the Forming of Dust-Pressed Tile," *Trans. Amer. Ceram. Soc.*, **19,** 409 (1917).

C. W. Parmelee, "Data on the Effect of Pressure Applied to a Dust Body," *ibid.*, **17,** 458 (1915).

F. K. Pence, "Study of the Effect of Variation of Pressure in Forming Dust-Pressed Tile," *ibid.*, **19,** 94–101 (1917).

is no distinct line of division where plastic clay touches a particle of flint clay. This improved union undoubtedly advances the progress of fusion.

While firing shrinkage is increased by increased forming pressures when normally fired, it is logical to expect this relationship to be reversed when the ware is fired much nearer its softening point. This is indicated by a certain amount of data, which, however, need to be further substantiated. The tile studies cited appear to bear out this conclusion.

Effect on Firing Treatment The data indicate that increase in forming pressure produces body changes which heretofore have been gained chiefly by firing to higher temperatures, and by prolonged heat treatment. This suggests the use of higher forming pressure and lower firing temperature to develop the same density and maturity which are now obtained by high firing. The greater green density by using higher forming pressure is the most encouraging improvement. Density secured by pressing instead of by extreme heat treatment would decrease kiln breakage and lessen kiln marking.

Another related possibility is that of applying a slightly higher forming pressure to brick set in the bottom of the kiln to correct for the differences in porosity.

Load Test The improvement in the load capacities of the plastic clay mixtures due to increased forming pressures was remarkable. Bodies C, D, and E, each of which has a P.C.E. of 29, were made equal to cone 30 and cone 32 brick by increasing the forming pressure. That the high flint clay brick should not be improved as much as the more plastic clay brick was expected, but a greater improvement than was obtained was anticipated.

General Consideration The investigation indicates certain advantages which would accrue from the utilization of forming pressure in excess of the present plant range. It must be realized that the ware resulting from the use of the very high forming pressure would constitute a type of fireclay refractory considerably different from those now manufactured. Fire brick which incorporate these advantages should find application in certain installations in which high resistance to thermal spalling is not a requirement.

The laboratory tests indicate that with higher forming pressure, a better brick will result for services where resistance to mechanical abrasion and slag action are required.

Poorer resistance to thermal shock and a greater shipping weight appear to be the only adverse factors. The greater mechanical strength may offset the tendency to spall through heat shock, since it should decrease mechanical spalling.

There must be a frank recognition of the forming difficulties to be overcome. Pressure cracking is the phenomenon which now limits the

forming pressure used in dry pressing. It has been shown that the pressure at which cracks appear can be affected by changes in the methods of body preparation, but such correctives are of limited effectiveness. This is evident from a study of Table IX. Only one of the eight mixtures was cracked while pressing at 3545 lbs. per sq. in. or lower, but after firing, five of the bodies exhibited cracks apparently traceable to the pressing operation. These cracks were generally developed from almost unnoticeable laminations in the green brick.

Evacuation of Mold Recent experiments,[10] which have shown the feasibility of forestalling laminations and pressure cracks by evacuating the clay in the mold during pressing, give promise of being the solution of the problem. A change in body structure is also thought to result from the displacement of air in the mold by certain other gases. The prospects for developing one of these or some other process industrially appear good. The work is being continued along these lines.

Conclusions

(1) The data reaffirm the finding that the physical properties obtained in plant presses (mechanically actuated) are produced by pressures ranging from less than 530 to about 1500 lbs. per sq. in. At these low pressures, failure to hold the pressure constant results in marked change in density and other related properties.

(2) Increase in the forming pressure of dry-pressed fire brick produces an increase in (*a*) firing shrinkage, (*b*) fired density, and (*c*) crushing strength. In addition, improvement is generally noted in load-bearing capacity and ability to resist slag attack and abrasion. Resistance to thermal spalling is decreased.

(3) The magnitude of these changes is decreased by the addition of flint fire clay.

Acknowledgment G. A. Bole directed this dry-press investigation, the Refractories Committee of the Ohio Ceramic Industries Association gave advisory supervision, and the Research Associates of the Roseville Experimental Plant, coöperated. Stuart M. Phelps, research fellow at Mellon Institute, conducted the load tests and Ralph K. Hursh, University of Illinois, made tests of slag erosion.

[10] R. E. Birch, "Evacuation of Air in Pressing of Dry-Press Brick Eliminates Pressure Cracks," *Brick Clay Rec.*, **76** [7], 436 (1930).

AN IMPROVED METHOD FOR DETERMINING THE TENSILE STRENGTH OF UNFIRED CLAYS[1]

By Stuart M. Phelps[2] and Vance Cartwright[3]

ABSTRACT

It is thought that knowledge of the tensile strengths of unfired clays is valuable and in view of this fact the present unsatisfactory method for its determination has been improved upon. A new apparatus and method for tensile strength determinations is described, in which the cast or pressed cylindrical test piece has a collar of low-melting alloy cast around each end, thus eliminating gripping difficulties and greatly increasing the accuracy. The apparatus is also adaptable to determinations of bond and transverse strengths of clays.

Introduction

The procedure to be described was evolved in a study of test methods that would be useful in evaluating the properties of unfired clays. There are but few satisfactory tests that can be used in determining the many properties of green clays, and since the tensile strength of these particular clays is of importance, a study of suitable test methods for the property of tensile strength was conducted.

The common method for determining tensile strength is that of breaking figure-8 test pieces in a cement testing machine. Such a test, however, is not entirely satisfactory and the results may vary by as much as 100%. These errors are largely the result of the difficulty in preparing satisfactory test pieces and the improper gripping of the clay test piece by the machine. The test pieces seldom break at the smallest cross-section, as would be expected. Furthermore, the fracture often occurs at the point of contact between the clay and the clamp. Attempts were made to overcome this difficulty by inserting blotters, rubber, etc., between the clamp and the clay. It was found that pitch, rosin, or sulphur could be poured between the test piece and the clamp, but such operations are not altogether desirable.

Development of Clamp

It was conceived that a suitable low-melting alloy might be cast about each end of the clay test piece so as to form a rigid material that could be clamped into the test machine. Experiments along this line proved the method to be highly satisfactory and the following alloy was found to answer the requirements:

	(%)
Bismuth	20
Lead	20
Cadmium	20
Tin	40

[1] Received June 18, 1930.

[2] Senior Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] Industrial Fellow, Mellon Institute.

A suitable alloy is one that contracts a small but definite amount upon freezing so that the clay test piece will be held securely during the test and yet not under enough compression to crush or weaken it. The above alloy melts at 130°C and is cast at about 145°C.

Shape of Test Piece

In view of the trouble experienced in preparing the figure-8 test pieces either by casting them or by molding from stiff-mud consistency, it was

FIG. 1.—Iron and plaster molds used for preparing test pieces.

decided to conduct the test upon small clay cylinders $^3/_4$ inch in diameter and 2 inches long. Test pieces such as these can be easily made either by casting or by stiff-mud molding.

A special iron mold was made to hold the clay cylinders so that a collar could be cast about each end. These collars were cast so as to leave exposed between them only $^1/_4$ inch of the clay. This split cast-iron mold is shown in the center of Fig. 1; in the left there may be noted a capped and an uncapped test piece. The same mold is also shown in Fig. 2 and attention is called to the depressions which are cast in the collar to receive the set screws used to hold the test assembly in the machine.

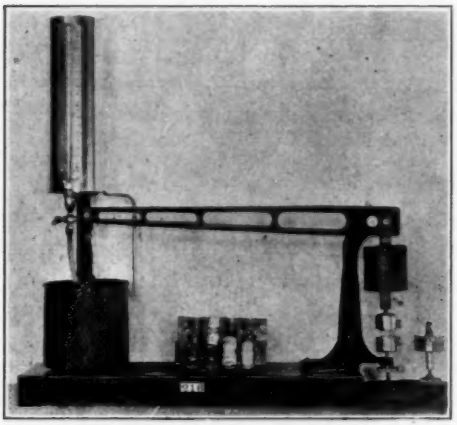

FIG. 2.—Test machine for tensile and bond tests.

The Test Machine

The test machine used for obtaining the tensile strength was designed so as to be as free as possible from personal errors. This is shown in Fig. 2, and consists, essentially,

of the ball-bearing pivoted lever of the ratio of twenty to one, which is counterbalanced by the lead weight shown at the right. On the opposite end of the beam there is placed an aluminum pail to receive the load. The calibrated container above the pail is equipped with an overflow so that upon filling it, the water will always be at its proper level. In front, there will be noted a water-level gage on each side of which there is a scale calibrated to read directly in pounds per square inch for either the tensile strength or the bond test. Below the counterbalance there will be noted the two receptacles which are in position for a tensile strength test. In conducting a determination, the water valve is opened until the sample breaks, and by noting the water level in the calibrated container, the tensile strength in pounds per square inch may be read directly from the scale.

Preparation of Test Piece

Several methods have been used for the preparation of the clay test pieces, such as by casting, by stiff-mud molding, and by extrusion. The method used will depend upon the nature of the clay and the manner in which it will be used eventually. When the clay may be readily cast, the following method of preparation is very satisfactory: Plaster molds are prepared such as are shown in Fig. 1. One of these molds is made with holes of different diameters and is used to determine the drying shrinkage of the clay sample. This mold is shown at "A" and is termed a "classifier." In front of it there will be noted the metal rods from which it was cast and each rod has a different diameter, namely, $^{48}/_{64}$, $^{49}/_{64}$, $^{50}/_{64}$, and $^{51}/_{64}$ inch. After casting the clay in the plaster mold, there is selected the test piece, which when dried, is closest to $^{3}/_{4}$ inch in diameter since other features of the test are based upon this diameter.

A note is made of the size of the hole in the classifier that produced this rod and subsequent test pieces are cast in molds of this size. For this purpose a block consisting of four holes, all of the same diameter, is prepared as represented by mold "B," Fig. 1. These holes happen to be $^{51}/_{64}$ inch and the number 51 stamped in the ends of the brass rods can be noted. This number is reproduced in the clay test piece and is particularly useful in the case of the Classifier Mold for identification of hole sizes. The clay rod shown in front of Mold "B," Fig. 1, has been cast, and when broken in half it makes two test pieces that are ready for capping.

Some clays, however, do not cast readily, in which case they may be either extruded, or pressed into plaster molds from stiff-mud consistency. An extrusion apparatus can easily be made from an automobile grease gun of the type that operates with a screw.

As is the case with any strength test conducted on green clay, care must be taken in the drying of the samples. These may be either air-dried or dried to 110°C and cooled in a desiccator.

Adaptation to Other Uses

The test data are unusually uniform so that the method should be useful in studying the effects of percentage of water, fineness of grind, organic bonds, electrolytes, rate and temperature of drying, and many other problems involved in treating clays. It will be found useful in testing types of bodies that cannot be adequately tested in the cement testing machine.

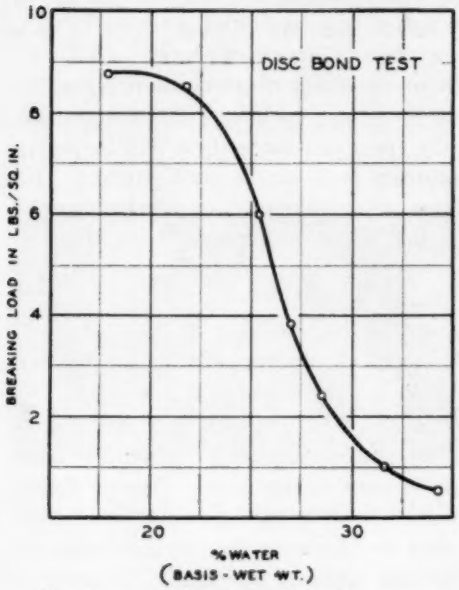

FIG. 3.—A typical strength-water curve.

Bond Test of Molding Sand Clays

The so-called bond test has been used in studying clays used for molding sands, and in order to make the test machine more complete, an attachment for this test was designed. The test consists of placing between two suitable disks the clay slip and noting the load that is necessary to pull the disks apart.

It was soon learned that the thickness of the clay film and the amount of water in the clay were very important factors. The thickness of the film was made uniform by inserting at the periphery three small pins that project above the surface 0.6 mm. Thinner films of clay give higher values of strength, but are difficult to form because high pressures are required.

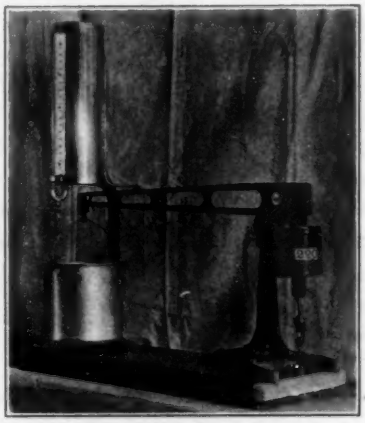

FIG. 4.—Test machine with transverse strength equipment.

It appears that the usual procedure for the bond test is not concerned with the amount of water used in preparing the clay. The importance of this factor can be learned from Fig. 3, which is a typical strength-water curve. All clays, however, do not show the same relation, and for this reason each should be tested with varying quantities of water. It would then be necessary to establish

some means of reporting the test value numerically. The nature of the surface of the bond test disk is important, as polished brass, hardened steel, and chromium-plated surfaces give different test values. The surface should be hard to prevent marring or scratching, and for this reason a highly polished hardened tool steel was used.

Transverse Strength Device A useful attachment that was added to the original test machine is the transverse strength device that may be seen in Fig. 4. This accommodates bars of a 1-inch square cross-section, 7 inches long. The maximum strength that can be handled is equivalent to 900 pounds per square inch.

Summary

The tensile strength test described is recommended particularly on account of its accuracy, a feature that has been one of the shortcomings of the usual method. The testing machine is a simple and yet accurate device for determining the values of tensile strength, bond strength, and the transverse strength.

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A UNIT ANALYSIS OF FELDSPAR[1]

By E. E. Pressler

ABSTRACT

A method of feldspar analysis is described by which all the major oxides are determined on one sample, and a practical routine procedure is developed on the basis of this method.

Introduction

In the usual analysis of feldspar, the members of the insoluble group are determined in sequence on the same sample, but for the alkalis, a second sample must be prepared, thus duplicating analytical procedure. In the first case, the soluble alkalis must be separated in turn from each member of the insoluble group, and in the second case, they must be extracted by a series of operations for their determination. The analytical economy in a method of direct determination of both groups on one sample is apparent.

Theoretical

The chief obstacle to the determination of the alkalis with the insoluble group is that decomposition of the sample is usually accomplished by fusion with a relatively large excess of alkali salts. Various alternative fluxes have been proposed to avoid the introduction of these foreign alkalis, among which may be mentioned the oxides of boron, lead, and bismuth. Decomposition of feldspar may also be effected by treatment with hydrofluoric acid.

That none of these methods has been found satisfactory, is evidenced by the fact that none has supplanted the ordinary method of sodium carbonate fusion. In any case, a foreign impurity is introduced, which must subsequently be removed by a more or less troublesome procedure. Hydrofluoric acid also interferes with the determination of both silica and alumina.

It was sought to avoid the introduction of sodium or potassium by the use of lithium as the alkali flux. It was found that decomposition by the carbonate is not readily accomplished, and furthermore, that the behavior of lithium salts in solution is not strictly analogous to that of sodium salts, particularly as to their effect in the dehydration of silica. It appeared, moreover, that little advantage would be found in the substitution of a salt of lithium, or any other alkali metal, for sodium or potassium salts as fluxing agents, because of the difficulty of their subsequent separation from sodium or potassium. Further efforts in this direction were therefore abandoned.

A modified method of decomposing aluminous silicates by sintering

[1] Received August 2, 1930.

with a limited excess of sodium carbonate is described by Finn and Klekotka.[2] Since the alkali introduced as a flux by this means is reduced to a relatively low value, the writer sought to establish experimentally whether a constant correction for it might safely be applied when the alkalis are determined on the filtrate from the insoluble group.

Experimental

After the usual analytical procedure, the filtrate from magnesium contains, aside from alkalis, only a large excess of ammonium salts and the excess of sodium phosphate introduced through the magnesium precipitation. The ammonium salts may readily be removed by volatilization, and the introduction of the nonvolatile sodium phosphate may be avoided by the use of 8-hydroxyquinoline[3] for the precipitation of magnesium. The filtrate from magnesium may then be used for the estimation of the alkalis, when corrections are made for the alkalis introduced by the flux.

With careful analytical procedure this method should yield very exact results. The individual separation of the various oxides of the insoluble group should favor the complete extraction of the alkalis above the usual J. Lawrence Smith method, in which the alkalis are extracted in turn from a relatively large mass of sintered material, and a heavy precipitate of calcium carbonate. Since sodium carbonate is only slightly hygroscopic, the sodium introduced by its use may be regulated with analytical precision. For use in sintering, a sampled portion of the powder is dried at 120°C, bottled, and preserved in a desiccator.

The value of the sodium carbonate blank may be found directly or empirically. The empirical determination is to be preferred, since it will reflect any discrepancy in the analytical results. For its determination, a sodium carbonate blank is carried through the entire analytical procedure, and the blank values for sodium and potassium oxides found. When subtracted from the corresponding values obtained on a Bureau of Standards, No. 70 sample of feldspar, the Bureau of Standards values should be checked. The direct determination may be made by dissolving the weighed sodium carbonate sample in an excess of dilute hydrochloric acid, evaporating to dryness, gently igniting, and weighing the soluble residue as chlorides. A double precipitation with perchloric acid is made to separate any potassium that the sodium carbonate might contain. The combined chlorides should approximate the calculated value for sodium carbonate.

After experimental tests on the Bureau of Standards standard sample

[2] Bur. Stand., *Jour. Research*, **4** [6], 809–13 (1930).

[3] J. Robitschek, "Use of 8-Hydroxyquinoline for Chemical Analysis of Silicates," *Jour. Amer. Ceram. Soc.*, **11**, 587 (1928).

of feldspar had shown that results within the normal limits of accuracy were obtained by this method, a practical laboratory procedure for routine analyses was developed.

Procedure

For general use in decomposing aluminous silicates, Finn and Klekotka recommend sintering at 875°C for two hours, using 0.6 gram of sodium carbonate powder for a 0.5-gram sample. In private conversation, Finn suggested that, for decomposing feldspar, a smaller proportion of sodium carbonate might be used. Tests were therefore made with the use of 0.5 gram of sodium carbonate for 0.5 gram of feldspar ground to pass a No. 200 sieve, and satisfactory results were observed. Further tests with 0.4 gram of sodium carbonate resulted in incomplete decomposition. The equal weight proportion of flux and sample was therefore adopted in local laboratory practice.

Decomposition appeared satisfactory with sintering at 850°C for two hours. At higher temperatures, a partially fused sinter resulted, which was difficult to remove completely from the crucible. Nickel crucibles are satisfactory when the temperature may be closely regulated. There is, however, occasional "scaling" of the crucibles, and, in case of fusion in nickel, the sample is difficult to remove without acids or other corrosive agents. When platinum is used, a fused sample may generally be detached from the crucible by alternate heating and cooling, and subsequently dissolved in acid solution.

After decomposition, the silica, alumina, and calcium oxide are separated as usual. The magnesium is then precipitated by 8-hydroxyquinoline in accordance with the method outlined by Hillebrand and Lundell.[4]

The solution is slightly acidified with hydrochloric acid, heated to 60 to 70°C, and 6 to 8 drops of a 5% solution of the reagent in 12% acetic acid added. After rendering the solution slightly alkaline with ammonium hydroxide, it is set aside for 20 to 30 minutes, and then filtered into a weighed Gooch crucible. The precipitate is washed with hot 2.5% ammonium hydroxide solution, dried at 130°C, and weighed as $Mg(C_9H_6ON)_2$.

The filtrate is transferred to a dry 500-ml. casserole, slightly acidified with hydrochloric acid, and evaporated to dryness on the water-bath. Overheating is best avoided. The dry residue is then transferred to a 75-ml. platinum dish as completely as possible by means of a steel spatula, and the spatula and casserole set aside for subsequent washing.

The platinum dish is then placed in a casserole radiator, covered with a 3-inch circular piece of platinum gauze, and the ammonium salts volatilized. When fumes cease to come off, the dish is removed from the

[4] Hillebrand and Lundell, Applied Inorganic Analysis, John Wiley and Sons, New York.

radiator, cooled, and the remnant of residue from the casserole and spatula washed into it with the minimum of hot water.

The solution is then evaporated on the water-bath, and the dish returned to the radiator and heated to dull redness. If there is danger of local overheating, the dish is gently ignited over a Bunsen burner flame. After cooling, the residue is moistened with hydrochloric acid, cautiously heated on the water-bath until danger of spattering is past, then evaporated and reheated as before. This is a precaution to assure complete conversion to chlorides, and may not generally be required. The dish with cover gauze and chlorides is then weighed, the residue taken up with hot water and filtered for the removal of any insolubie residue; and the platinum with ignited filter paper weighed to find the combined chlorides by difference.

The separation of the alkalis is made by double precipitation with perchloric acid, to prevent the possible occlusion of sodium in the potassium perchlorate crystals.

Routine Schedule

For most effective results, a daily schedule for routine work is essential. It is found convenient to sinter the samples at night, using an automatically controlled electric furnace. Duplicate samples on each car shipment are therefore prepared for sintering on the day received. Ignition loss determinations are made on separate 5-gram samples, which may later be used for the determination of iron. On the morning of the second day, the sintered samples are dissolved and evaporated, and in the afternoon the first filtration of silica is made. In the evening, the solutions are placed on the water-bath for evaporation at night. On the morning of the third day, the silica residues are dehydrated at 110°C for 45 minutes, after which the second silica filtration is made. The alumina is then separated by double precipitation, after which the calcium precipitation is made. This should be accomplished before noon. As the combined filtrates from alumina are usually in excess of 600 ml., the evaporation of the solution is continued after the calcium precipitation until the volume is reduced to about 250 ml. Care is observed to keep the solution alkaline during evaporation by the addition of dilute ammonium hydroxide from time to time, as required. Four hours after precipitation, the calcium oxalate is filtered. The magnesium is then precipitated and filtered, and the filtrate acidified with hydrochloric acid and prepared for evaporation at night. The determination of the combined chlorides and the separation of the alkalis may be done conveniently during the following day.

By this means, a complete analysis of feldspar is made on a convenient schedule in four days, and the analytical work required is reduced from

the usual practice by approximately one-third. When a regular schedule is observed, one analyst will complete two analyses per day.

Importance of Complete Analyses

The chief value of complete analyses of feldspar is that it permits checking the summation of totals to 100%. In the usual case, the silica tends to run low, due to incomplete recovery, even with double evaporation. The other oxides of the insoluble group are commonly too high; which may be due, in some cases, to an accumulation of dust or other solid contaminants. Such factors would usually be excluded in the case of silica when hydrofluoric acid volatilization is used, but not in the case of the other oxides. There are, moreover, other factors which tend to cause high values for these oxides, the most important of which are those affecting alumina.[5] The combined alkalis are less subject to significant plus errors than are the combined oxides of the insoluble group. This may be due to their separation by extraction, by reason of which any foreign contaminant is ordinarily removed by filtration.

Correction Factors

On two complete analyses of 0.5000-gram sodium carbonate blanks, the values for combined chlorides observed were 0.5526 and 0.5520, averaging 0.5523 gram, as compared with a calculated value of 0.5515 gram. An average value of 0.0008-gram potassium chloride was found. The average results observed on four 0.5000-gram samples of sodium carbonate determined directly was 0.5505, with a maximum variation from the mean of 0.0003 gram. The difference between the average empirically-determined and direct results represents the alkali introduced through foreign sources in the course of the analysis.

These results show that consistent correction factors are obtained by both empirical and direct determinations, and that these show fair agreement with the theoretical value.

Application

Although the method is developed specifically for feldspar, it has a general application for aluminous silicates which may be decomposed without introducing a large excess of sodium carbonate.

Summary

A unit analysis of feldspar has been developed, by means of which all the major oxides of feldspar may be determined on the same sample.

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[5] Hillebrand and Lundell, *loc. cit.*, p. 395.

A practical routine procedure for feldspar analysis is outlined, which permits a routine schedule of two analyses daily per analyst.

The limits of accuracy found by parallel blank tests are shown to be within the usual analytical limits, and results check the theoretical values.

The principle of the method is applicable in general to aluminous silicates, which may be decomposed without the introduction of a large excess of sodium carbonate.

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AIR CONDITIONING IN CERAMICS[1]

By H. B. Matzen and C. E. Parmelee

ABSTRACT

This paper outlines the general factors considered in an air-conditioning problem. The present type of applications in the ceramic industry include (1) complete drying of ware, (2) conditioning of material and formed pieces, (3) humidifying and dehumidifying of manufacturing departments, (4) air washing, (5) cooling for comfort. Illustrations showing details of some of these cases are included. The present progress indicates the general line of future development of air conditioning in the manufacture of ceramic products.

Introduction

The purpose of this paper is to present an outline of the well-developed, though relatively new, art of "air conditioning"; to show how it has been applied to many industries for the solution of problems in handling materials sensitive to atmospheric conditions; and particularly to point out how this science has already been applied in the ceramic industry for the solution of various problems in this line of work.

Air conditioning simply defined is the automatic establishment and control of desired conditions of temperature, relative humidity, air circulation, and, usually, air purity. A true air-conditioning problem usually involves all of these factors.

The application of air conditioning to a specific problem involves a knowledge of the laws governing temperature, humidity, and air distribution as well as an understanding of the effect of these factors on the materials treated.

The fundamental laws of atmospheric conditions and their interrelations have been quite definitely laid down. The instruments, devices, and equipment for producing atmospheric control have also attained a high state of development.

A bibliography is appended.

Drying

The first and most obvious applications of air conditioning in the ceramic industry were made in drying.

For a great many years engineers seem to have considered that either the application of heat, or a combination of heat and air circulation was all that was necessary to remove moisture from a ceramic body. The tremendous losses experienced and the uncertain schedules which resulted, were accepted as necessary evils. Considerable attention of an experienced operator was required to watch the material as it was being dried, in order to keep down the breakage and yet dry the ware in a minimum

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received April 28, 1930.

period of time. Moisture was frequently removed too rapidly from the surface, resulting in uneven stresses being set up in the material while being dried, producing checking, and in some cases, severe cracking, which became evident only after the added investment of firing.

To prevent this rapid surface drying, pieces were covered with wet cloths and dried at low temperatures with a very slow air circulation. This expedient reduced spoilage, but usually at the expense of time and schedules. It was recognized that the proper way was to remove the moisture "from the inside out," but the principles involved were little understood.

Actually and simply, the problem is not to dry from the inside out but to control the rate of evaporation from the surface of the object being dried so that this corresponds exactly with the rate of the diffusion of moisture through the piece to the surface.

Factors Affecting Rate of Moisture Removal

Density of Ware Obviously, the characteristic density or resistance of the material being dried determines the rate at which interior moisture can be brought to the surface at any given temperature and this in turn determines the rate of drying. This rate of drying cannot be exceeded without impairing the physical structure of the material.

Critical Temperature For each material there is a definite temperature at which the moisture will move outwardly toward the surface at the fastest allowable rate. This then is the critical temperature at which the material should be dried. One of the fundamental facts which has been discovered, is that during the period of shrinking, the temperature of drying clay bodies follows the variations in the wet-bulb temperature of the air. This does not mean that the temperature of the material is the same as that registered by a thermometer covered with a wet wick, but that each variation in wet-bulb temperature will cause a similar variation on the temperature of the clay surface.

It is, possible therefore, through control of the wet-bulb temperature of the air coming in contact with the material being dried, to control accurately the temperature of the material itself.

By regulating and advancing the wet- and dry-bulb temperature of the air so that evaporation at the surface occurs at all times at a rate corresponding to the diffusion of the moisture to the surface, case hardening is avoided and the drying progresses at the fastest possible rate.

Rate of Moisture Movement in Ware In most cases the rate of moisture progress from the interior to the surface varies as the drying proceeds, being slowest at the beginning and increasing as the temperature of the body is increased. Thus, to dry in the shortest possible time, this rate of moisture movement must be determined and the relative humidity or the relation between the wet- and dry-bulb

temperatures, must be altered, either continuously or at fixed intervals of time so that the surface moisture is always evaporated as rapidly as it appears.

This is precisely what is done by means of automatic control instruments in the modern drier. Figure 1 illustrates a typical drying cycle in use for complete drying. It may be seen from this illustration that both the wet- and dry-bulb temperatures are closely regulated through the first part of the cycle. After the piece is thoroughly heated up and a maximum safe evaporation of moisture has been established, the humidity is decreased and the dry-bulb temperature is maintained at a definite point. This illustrates the characteristics of complete drying in relationship to the wet- and dry-bulb temperatures, moisture loss, and shrinkage.

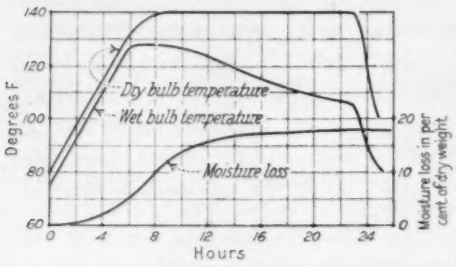

FIG. 1.—Typical drying schedule for complete drying, showing dry- and wet-bulb temperatures and moisture loss.

Air Circulation

It should be obvious that even if means are provided for automatically controlling conditions of temperature and humidity of the air supplied to the drier, uniform effects are not assured without controlling the velocity of the air moving over the material being dried and the uniformity of its movement over all parts of the material. Success of the whole process depends upon circulation.

Faulty distribution is found in the waste-heat tunnel drier with a horizontal flow of air. The air tends to travel on the outside of the cars and produces rapid drying of the pieces on the outside. This differential air flow is due to variable resistances and results in the slow drying of the interior portions of the car.

Velocity and Direction of Flow

Closely connected with air distribution is air velocity. The effect of air conditions can be materially altered by changes in air velocity.

Drying varies not only with the velocity but with the direction of flow relative to the evaporating surface. Attention is directed to the following equations for rate of evaporation with parallel and transverse flow air.

The rate of evaporation with parallel air flow may be determined from[2] the formula,

$$H = 97\left(1 + \frac{V}{230}\right)(e_w - e_a)$$

[2] See reference No. 6, p. 864.

Or with the transverse air flow from

$$H = 200\left(1 + \frac{V}{230}\right)(e_w - e_a)$$

Where H = B.t.u. per sq. ft. per hr.
V = longitudinal velocity of the air in ft. per min.
e_w = vapor pressure in inches of Hg. corresponding to water temperature or the temperature of the surface being dried
e_a = vapor pressure of the moisture in the air

These equations and the accompanying graphs (Fig. 2), it will be noted, are in terms of heat-transfer rate. To convert these to rate of evaporation, it is simply necessary to divide by the latent heat of water vapor corresponding to the temperature of the evaporating surface. Thus

$$W = \frac{H}{r}$$

Where W = lbs. of water evaporated per hr. per sq. ft. of surface
r = latent heat of water vapor at the temperature of the evaporating surface

From this it may be seen that direct impingement of air on a piece of material to be dried results in a much greater rate of evaporation than if the air passes parallel to the piece. From this the importance of the proper rate and character of the air flow may be seen.

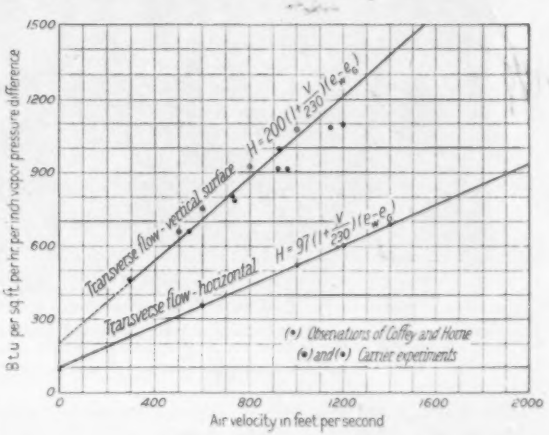

FIG. 2.—Curves showing B.t.u. transmission from a water surface for transverse and parallel flow of air.

Controlled Limit Drying

From the ordinary complete drying of clay bodies, a new and interesting application of air conditioning is studied, which is termed, "controlled limit drying." This applies where it is desired to bring filter cakes or cast or molded clay bodies down to a definite and limited moisture content preparatory to some treatment before final and complete drying.

One of the fundamental principles in evaporation and in the relation between evaporation and the moisture content of materials is that a given material will hold a fixed amount of moisture corresponding to the relative humidity of the surrounding atmosphere. It is, therefore, possible within certain limits, through the control of relative humidity, to check the drying

of a material at any desired point and thus to hold a desired and fixed moisture content.

Such clay bodies usually contain a considerable amount of moisture, as much as 25 or 30%. In the case of filter-press cakes for dust-pressed tile, it is desired to condition the clay to a moisture content of between 8% and 11%. The usual tolerances are plus or minus 1% for dry pressing of material for tile or low-tension electrical porcelain. Here the problem is not essentially one of moisture removal, but resolves itself into a combination of removing water to a certain point and leaving a correct and uniform distribution of the remaining moisture throughout all the material.

One method of handling filter-press cakes is shown in Fig. 3. Here the

FIG. 3.—Method of handling filter-press cakes on trucks to permit uniform air circulation for controlled limit drying.

cakes have been placed on trucks in tiers with sufficient space between each shelf to permit the proper flow of air.

Another application of controlled limit drying has been made in the conditioning of what is known among the electrical porcelain manufacturers as tube stock. Cylindrical pieces are delivered from the pug mill with a high moisture content. These pieces range in diameter from four to eleven inches and usually have a hole through the center. The lengths vary from 16 to 36 inches so that it is common to have a considerable mass of clay in one piece. It is necessary to remove enough of this water to leave the piece in a leather hard condition so that the desired shape may be turned and shaped on a lathe. This means limiting the drying so that the piece retains from 10 to 20% moisture according to requirements of the par-

ticular stock. It is essential that the pieces when conditioned reach a definite and uniform moisture state.

Figure 4 shows the character of the blank pieces when conditioned and the shape which has been turned out of this tube stock. The range in sizes frequently found in such work is well illustrated.

Future Drying Possibilities

Rapid replacement of the slow and inefficient hot floors with better equipment is being made for refractories, especially the hand-molded shapes and electrical conduits.

The more rapid drying obtained by application of air-conditioning prin-

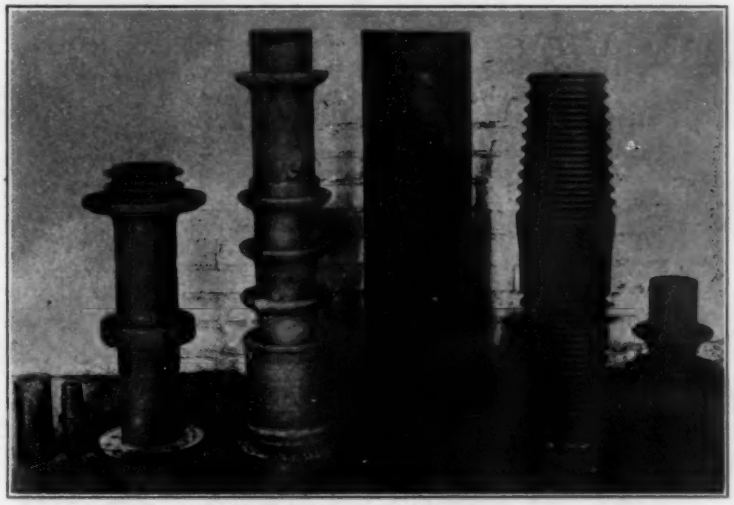

FIG. 4.—Typical blanks and finished tube stock conditioned by limit drying for the electrical porcelain.

ciples together with the methods of stocking ware in tiers in the modern driers has greatly reduced the required floor space. Where the hot floor is in use, the required space has been cut to about 25% of the original requirement and the reduced time of drying has further reduced the space requirements perhaps to one-tenth that formerly used. Floor space is figured as worth 20 cents per square foot per year. This amounts to a large item and often a considerable investment in such an equipment has been warranted from this standpoint alone. A sanitary ware manufacturer was enabled to double the production of the casting department when drying equipment replaced the large area of drying racks formerly used.

Heat and fuel economy are further important contributions of the modern

drier. The walls and ceilings conserve heat through proper design and insulation. Even more important than this is the fact that the heated air is recirculated over and over the material. Outdoor air is brought in only under automatic control to maintain the desired humidity.

Air Conditioning Aside from Drying

Conditioning Casting Rooms

Air conditioning has found a number of advantageous applications in ceramic plants quite aside from the drying operation. Thus in casting shops where extensive slip casting is being done, air conditioning has a very definite place.

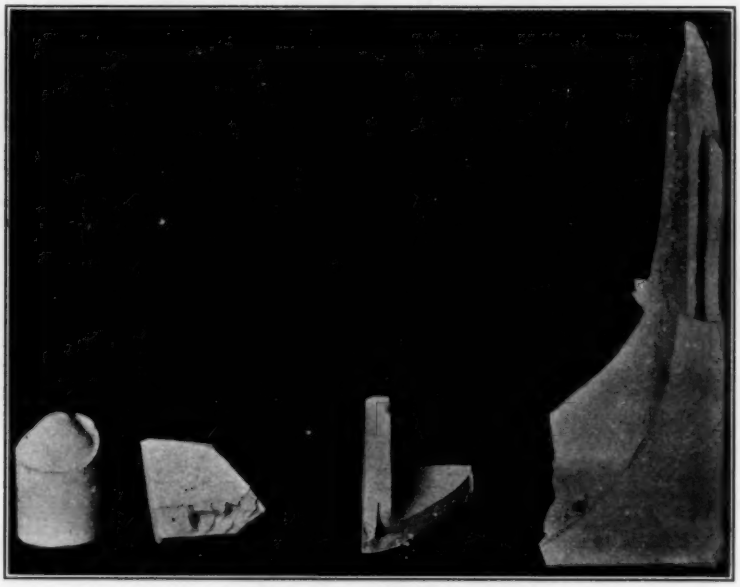

FIG. 5.—Casting results from molds which are not properly conditioned. Piece on left is an example of a "balled" cast from a mold which was too dry; piece on right a hollow cast obtained from a mold which was too wet.

Plaster of Paris molds absorb moisture from the slip at a rate whcih depends upon the initial moisture content of the mold. A mold that is too wet will not cast quickly or solidly. A mold that is too dry will cast too rapidly, leaving a hollow wall in double-cast pieces. Figures 5 and 6 illustrate this effect of moisture content in plaster of Paris molds upon the casting of sanitary ware. Figure 5 illustrates two examples of the extreme condition of wet and dry molds. On the right is a typical hollow cast. On the left is the balled cast. Figure 6 shows the results obtained from a mold

that was in the proper moisture condition. The two illustrations on the right are nearly perfect casts.

We also have the problem of preparing the molds for the next casting. Will they be ready, or at the correct moisture content? Probably not, and the operator resorts to the customary "doctoring" by sponging in winter to add the water that the extreme dryness of the shop has extracted; by dusting with powdered clay to counteract the wetness of many spring and summer days. But this is a rule-of-thumb process and production schedules become dependent on the personal equation. Controlled humidity to bring about a balanced moisture content or, once again, "limit drying"

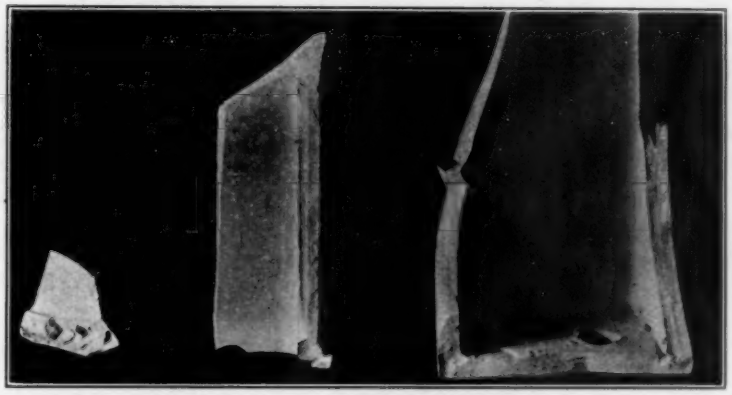

FIG. 6.—Large section showing a uniformly solid cast obtained from a mold of the correct moisture content.

can be depended upon to keep molds right and give good casting every day. This also brings with it longer life for the molds.

Conditioning Decorations Shops

Decalcomania sheets are highly responsive to variations in air conditions. With the arid dryness of winter conditions we find such paper shrinking slightly and the small pieces cut for application, curling badly. Also the "varnish" or "dope" used in the application of the decals to the chinaware reacts quickly to changing weather.

In the latter case, the fast or slow drying is offset by doctoring the "varnish," similar to the obsolete methods of the printer in altering his ink. But the shop foreman is only an amateur weather man and frequently finds that by noon his predictions are wrong and the varnish once more must be changed. Then in the extreme dryness of winter it has been frequently necessary to shut down for the day as the varnish is in an impossible working condition.

Improved Working Conditions Naturally, any control of temperature, humidity, and air motion also provides much better working conditions. These improvements in working conditions are not to be regarded as simply an added benefit to employees without any return to the company. Increased production, improved labor turnover, fewer errors, and less faulty workmanship, are among the factors which tend to make air conditioning, considered as an improvement in working conditions alone, a profitable investment. More specifically, the use of air conditioning in providing comfortable operating conditions that are usually extremely unpleasant has received some attention. The efficiency of furnace operators handling large enamelware pieces has been greatly increased by giving them a cool area in which to stand between charges. The extreme heat of the furnace and hot summer weather has reduced production in some of these enameling plants as much as 30%. This is sometimes offset by working the men shorter hours when labor conditions warrant the use of many shifts. Such a method, however, is not a sure cure and the only manner in which the manufacturer can insure adequate production under all conditions of weather and labor is by the application of such cooling methods.

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A RAPID-FIRE TUNNEL KILN DESIGNED FOR SMALL PRODUCTION[1]

By A. L. Donnenwirth

ABSTRACT

A miniature tunnel kiln was designed to fire spark plug porcelain to cone 17. It is capable of producing about 10,000 porcelains daily. The total firing time is only slightly more than two hours. The kiln, its operation and efficiency is detailed.

Introduction

The production of spark plug porcelains in the French factory of the A C Spark Plug Company did not exceed 5000 daily. They were fired in a periodic kiln, two firings per month. This made necessary the accumulation of unfired porcelain stock. The space required, the loss in handling, and the handling labor made the manufacturing costs exceedingly high. Rush orders were out of the question.

This situation made it imperative to design a small continuous kiln.

The Kiln

The kiln installed is a development from the kiln described by McDowell and Helser.[2] Two kilns have been built. The first kiln is 52 feet long and is built on a structural steel table approximately 36 inches high. It is only 36 inches wide at the widest section and about 6 feet high over all. (See Fig. 1, front end of kiln.) The second kiln is 110 feet in length.

The kiln is divided into six zones, namely: entrance zone, preheating zone, firing zone, indirect air-cooled zone, water-cooled zone, and the direct air-cooled zone. Cross-sections taken through these different zones are shown in Fig. 2 (*a*, *b*, *c*, and *d*).

The burners are placed one on each side of the kiln and about 12 inches apart. They are inclined upward so that the flames impinge on the arch, heating it and the side walls. The ware is then fired by direct radiation from these surfaces.

The combustion gases travel slowly toward the front end of the kiln where they are exhausted by natural draft through a sheet metal stack. To prevent the combustion gases from traveling toward the exit end, a baffle wall (as shown in Fig. 3) is built at the end of the firing zone. The opening in this baffle is just large enough to permit the ware to pass through.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received March 3, 1930.

[2] "Data on Operation of a Continuous Tunnel Kiln at Plant of A C Spark Plug Company," *Jour. Amer. Ceram. Soc.*, 5 [6], 267 (1922).

Cars

The cars are $7^1/_8$ inches long and $2^5/_8$ inches wide (Fig. 4). The metal structure is made of cold-rolled steel except the wheels which are made of

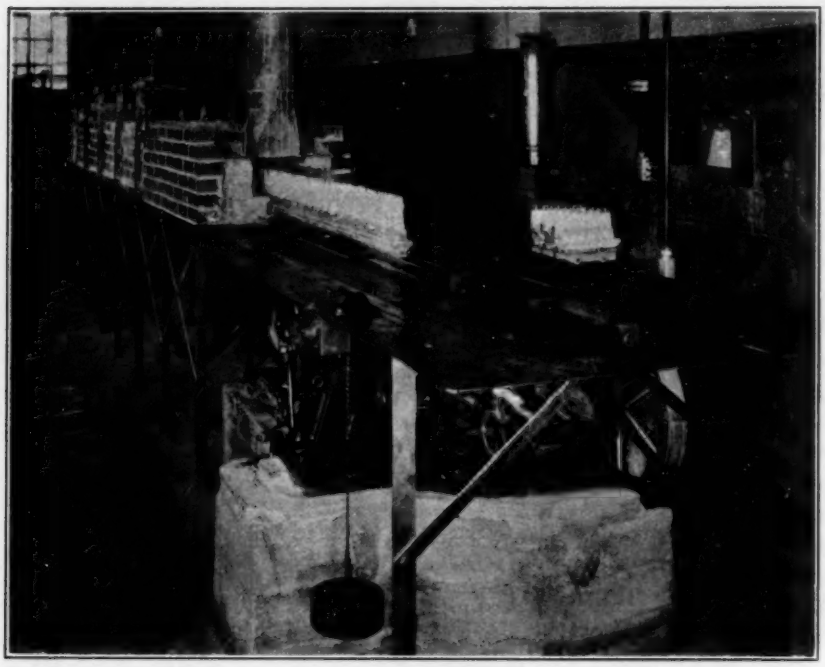

FIG. 1.—Front end of kiln.

monel metal. Refractory pins are inserted into the holes of the refractory car top and spark plug porcelains are placed on these pins. The thickness of the uppermost part of the refractory car is made as small as possible so as to reduce to a minimum the amount of heat absorbed by the car refractories.

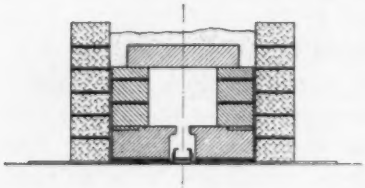

FIG. 2*a*.—Section through entrance zone.

Track

The track is made of stainless steel and is water tight. Water is run through it to aid in keeping the temperature of the car structures as low as possible.

Pusher

The pushing mechanism is unique in design. It consists of a steel

drum, the shaft of which lies parallel with and directly beneath the kiln track. Two grooves 2 inches wide and 1 inch deep are cut around the circumference of the drum (Fig. 5).

Two steel dogs, which engage at the back of the cars, move on a slide

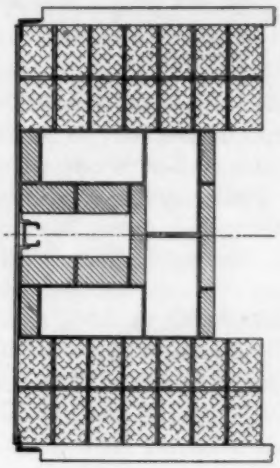

FIG. 2d.—Section through air-cooling zone.

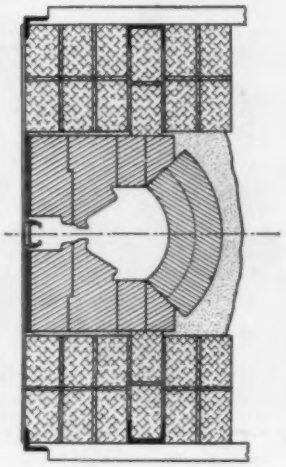

FIG. 2b.—Section through preheating zone.

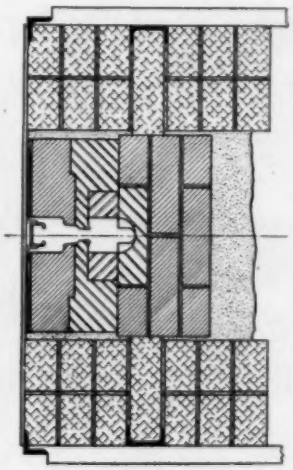

FIG. 3.—Section through baffle.

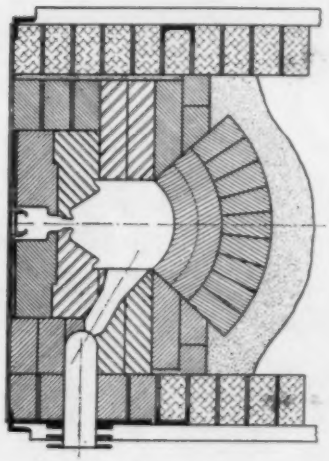

FIG. 2c.—Section through hot zone.

directly over the drum and are connected to the drum by means of a vertical roller which fits into the groove. The grooves are arranged in such a manner that as the drum is revolved both dogs move forward with two

cars between them. While the fore dog is still moving forward, the rear dog will drop back and push on the third car. Both dogs will again move forward for a distance until the rear dog is advancing as fast as the fore dog, then while the rear dog is still advancing the fore dog will disengage, drop back one car length, and advance again.

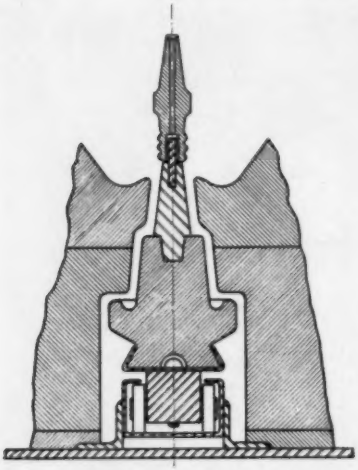

FIG. 4.—Section showing clearance between car and kiln wall.

Firing

The kiln is fired to cone 17T using light distillate fuel oil (Baumé 30°). The oil consumption is one gallon per hour per burner or forty-eight gallons every twenty-four hours making the daily fuel cost approximately $3.25.

One man operates the kiln, inspects all the ware as he loads it, and again inspects it after it is fired.

A car enters the kiln every minute and a half. It travels twenty-four feet every hour resulting in a total firing time of two hours ten minutes.

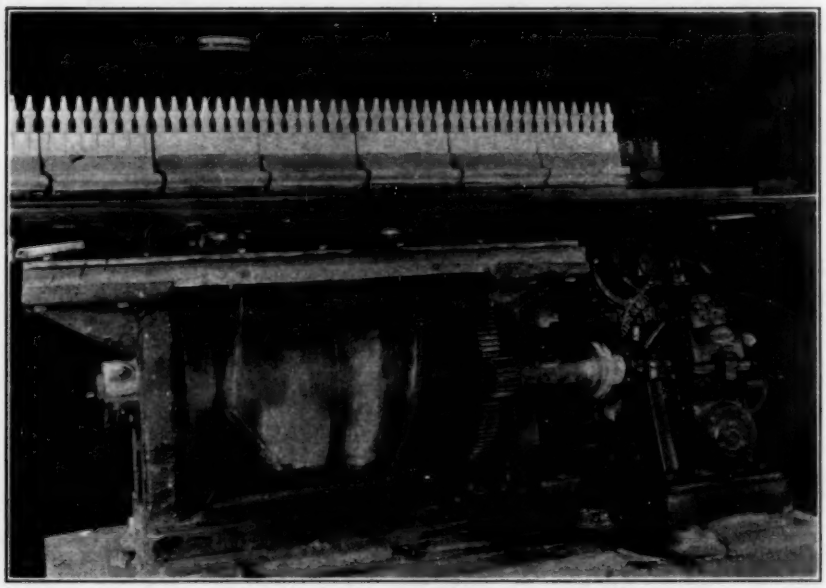

FIG. 5.

Discussion

This rate of firing is very rapid and at first considerable trouble was encountered due to preheating cracks. By a careful selection of the clays used, this difficulty was overcome.

By changing the design of the car tops and the baffle at the end of the firing zone (Fig. 6), faience tile was gloss fired successfully in this kiln. We were not able to fire faster than a two-minute car schedule as the particular body used developed cooling cracks. Glazes maturing at cones 9, 5, 1, and 01 and gold at cone 018 were fired and found to be equally as good as the glaze fired in the large production tunnel kiln.

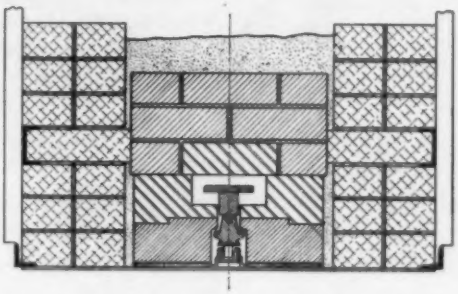

FIG. 6.—Section through baffle to fire faience tile.

A 52-foot kiln in our experimental laboratory using city gas as fuel has been operated at various temperatures up to as high as cone 23 (Fig. 7, exit end of kiln).

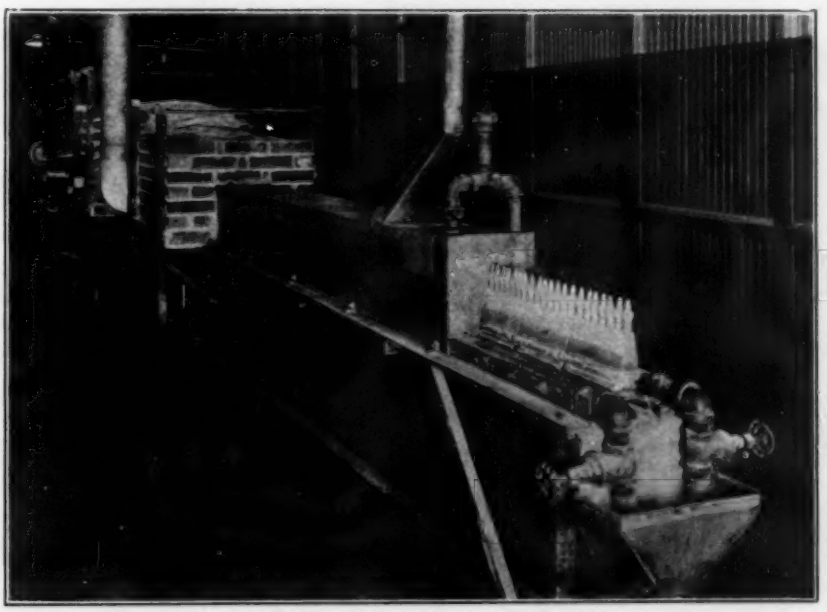

FIG. 7.

Conclusions

The type of ware which can be successfully fired in this type of kiln is naturally limited. For our particular product, however, we materially reduced the operating costs by the installation of this kiln which represents an investment of only $3000.

AC Spark Plug Co.
Flint, Michigan

THE CAUSE AND PREVENTION OF CERTAIN BROWN STAINS ON SEMIVITREOUS TABLEWARE[1]

By G. A. Loomis[2]

ABSTRACT

It has been found that the brown stains formed on ware bedded in sand in the bisque fire are due to a reduction of iron in the sand. This reduction is apparently due to insufficient air in the saggers during oxidation of the ware when the kiln atmosphere is low in excess air. Firing the ware in saggers with holes to allow a circulation of air prevented the stains. The ware may also be fired in closed saggers without these defects by admitting sufficient excess air to the kiln and allowing more time at low oxidation temperatures.

Introduction

In the course of an investigation[3] of periodic pottery kiln firing, it was learned that one of the potteries manufacturing semivitreous tableware had been unable for more than a year to fire ware placed in sand in the tunnel kiln bisque fire, due to the ware becoming peppered with brown stains wherever it came in contact with the sand.

The "dishes," which were placed in sand are meat platters and similar articles made without a "foot." This ware was stacked in saggers with sand between each piece.

While this ware became stained in the tunnel kiln no difficulty was experienced using the same sand in the updraft kilns. For this reason all ware of this kind was being bisque-fired in the updraft kilns.

The tunnel kiln was used by this company alternately for bisque and gloss firing and it was believed that this practice was responsible in some way for the difficulty, although when the kiln was first started no trouble with the brown specks was experienced.

Different sands were tried but the trouble was not removed. It was found that the ware could be fired without being stained by bedding in flint but this material was more expensive and more difficult to clean from the ware.

Other potteries making the same type of ware have been troubled at times with these brown stains on the ware in the bisque fire, not only where tunnel kilns are employed but in periodic kilns as well.

It seemed quite evident that the brown specks in some manner could be laid to some condition in the tunnel kiln not present in the updraft kilns. The sand used, though comparatively pure, contained numerous black and brown grains which were believed to be an iron-bearing mineral. It seemed that the stain on the ware might be due to a reduction of this

[1] Received June 18, 1930.

[2] Research Engineer, Eng. Expt. Station, Ohio State Univ., Columbus, Ohio.

[3] By the Engineering Experiment Station, Ohio State University, in coöperation with the Ohio Ceramic Industries Association.

iron by the kiln atmosphere. The reduced iron, melting at a lower temperature than if fully oxidized, would stain the ware.

The Investigation

Gas Analysis at Kilns Samples of the tunnel kiln atmosphere were drawn by means of a water-cooled sampling tube inserted through peep holes at several points between the charging end of the kiln and the fire zone. The lowest result obtained on analysis was 28% excess air at a point nearest the fire zone. Tests on the updraft kilns showed an excess air percentage almost as low as this when nearing the maturing temperature.

Laboratory Tests Still believing that the brown specks were due in some way to iron in the sand being reduced, specimens of the sand and unfired ware were taken to the Engineering Experiment Station in Columbus for tests.

Samples of the sand were examined microscopically. The Illinois sand, regularly used by the company, was found to contain a considerable amount of a black opaque mineral, which tests indicated was very high in iron content. Some of the grains were merely stained by what appeared to be iron. The black grains were non-magnetic. A few were found to be organic, probably coal. The Pennsylvania sand, which had proved slightly better in use than the Illinois sand, showed a smaller percentage of iron mineral.

Some of the ware was set in a small muffle furnace with some of the sand between, simulating factory practice; one set with the regular Illinois sand, one with the Pennsylvania sand, and one with the Illinois sand to which a high percentage of iron-bearing grains previously separated from a larger sample had been added to make a concentrated mixture.

The furnace was fired to cone 8 in about three hours. The atmosphere in the muffle was maintained in a reducing condition throughout the firing by passing a stream of natural gas into the muffle through a porcelain tube.

A sample of the kiln atmosphere drawn just as cone 8 went down showed only 0.4% oxygen and 7.4% carbon monoxide, indicating a strongly reducing condition.

On cooling, the ware was found to be covered with the typical brown specks wherever it had been in contact with the sand. The ware in contact with the "concentrated" Illinois sand showed the most and the largest specks. With the regular Illinois sand the ware also was quite badly specked. The ware in contact with the Pennsylvania sand was stained the least, but to an objectionable extent the same as in the tunnel kiln.

A test was then made in the muffle kiln, using a stream of air to insure oxidizing conditions. Cone 8 was deformed in about three hours, at

which time a sample of the kiln atmosphere showed 123% excess air. After cooling, none of the specimens showed any brown specks.

Another test in which the ware was fired to cone 9 in practically a neutral atmosphere gave a similar result to that under reducing conditions. It appeared quite evident that the trouble in the tunnel kiln was due in some way to a lack of sufficient air. With adjustments made on the kiln which increased the excess air slightly, there was a slight decrease in the extent of staining.

Oxidizing Conditions Obtained

It was noted that the top piece in each stack of ware, although covered with sand was not specked as badly as those below. It was known that a manufacturer of high tension insulators found black coring which was due to incomplete oxidation of the organic matter in the body before vitrification took place. He obtained complete oxidation by cutting holes in the saggers to permit a circulation of air around the ware. The clays used for the ware being studied contain a high percentage of organic matter in the dead atmosphere of a sealed sagger surrounded by insufficient air. This organic matter oxidizes slowly and robs oxygen from the iron in the sand. Therefore, ware was bedded in sand in some saggers having holes in each end to permit a circulation of air through the sagger. Some of the same ware was similarly placed in closed saggers on the same cars. Adjustments of the kiln dampers were made to increase the excess air and to increase the temperature toward the charging end to bring about earlier oxidation of the ware.

The ware placed in the saggers provided with holes proved to be free from the brown stains while that in the closed saggers was stained almost as badly as ever.

By adjustment of the kiln dampers to provide sufficient excess air at all times and to preheat the ware at a sufficiently early stage in the kiln to oxidize the organic matter in the ware completely before reaching the temperature of dissociation of the iron in the sand, the company is now able to fire the ware free from the stains even in closed saggers. As a safety precaution, however, it is now the regular practice to fire the ware bedded in sand in the tunnel kiln in saggers provided with holes.

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COLUMBUS, OHIO

NOTES ON CASTING SLIP[1]

By Leslie Sample

Abstract

This is a note showing the unreliability of viscosimeter control for casting slip. A rule is given for control of the "hardness" and thickness of slip.

Introduction

The main requisite of a casting slip is that it produce a cast piece neither too hard nor too soft after the core is pulled or the mold drained. Slip producing a hard piece is "hard" slip, a soft piece, "soft" slip. Normally a hard slip is thin, a soft slip thick, or viscous, and so the viscosimeter is used as a control for the "hardness" of the slip.

There is no question but that the viscosimeter is in many instances of great help, and there are possibly some cases where it is reliable, but these cases are due to local conditions, and are not sufficient to warrant the assumption that the viscosimeter is a reliable control instrument under all conditions.

Case of Unreliable Viscosity Control

It was the writer's privilege to spend some time with a sanitary-ware plant which used the Ohio River as a source of water for slip making. Viscosimeter control was used, and would function satisfactorily for some time; then the casting shop would complain that the slip was "off." The slip house would counter that the viscosity was perfect and that the casters were "off." The specific gravity was maintained constant. Temperature variations were so small that they were not taken into account. Checking the slip with the cup test showed that the casters were right, that the slip did vary in its hardness despite the constant viscosity.

Test for Hardness of Slip

The cup test consists of pouring slip into a small mold which is kept as nearly as possible at a uniform moisture content, allowing the slip to cast for a standard time, generally from five to ten minutes, draining the mold inverted for another standard time, generally between one and two minutes, then tearing the cast from the mold and working the cast piece in the fingers, noting the hardness or softness of the cast. A soft slip will produce a soft cast which will be malleable in the fingers for a long time; a hard slip will produce a hard cast which may break or tear in taking from the mold, and will get hard and crumble in the fingers after working a few minutes.

After draining and before tearing from the mold, the thickness of the

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received March 10, 1930.

cast can be observed and measured, giving the rate at which the slip will set up, which is another variable factor in slip making (a factor which is important but which receives scant attention).

There is another hardness test where the slip is cast solid in a small mold, the piece removed and subjected to impact from a falling weight, the depression so formed measured, giving a hardness figure. This is a good test, but requires considerably more time.

Controlling Thickness of Slip

The standard electrolyte consisted of a fifty-fifty mixture by weight of sodium silicate and sal soda. Controlling the slip by the cup test, using the standard electrolyte, it was possible to maintain the slip at a comparatively uniform hardness by increasing or decreasing the salts; the more salts, the harder the slip. This, however, produced slip at times so thin that trouble was experienced with the molds leaking; at other times the slip would get so thick it would cause the slip pump to labor.

While it did not always hold true, the thin slip would set up more slowly than the thicker slip. Thick or thin, at the standard hardness the slip produced good ware.

One trouble appearing was that on aging the slip did not always become softer, as one would naturally expect, but sometimes would become harder.

To overcome the thick and thin slip, it was necessary to change the ratio of one salt to the other. When the slip became thick, more sal soda than sodium silicate was used, the ratio going at times to three sal soda to one silicate of soda. When the slip became thin, it would take more sodium silicate than sal soda, sometimes three to one. Thus, by constantly changing the ratio of the salts, it was possible to maintain a slip of constant hardness and comparatively constant viscosity.

There were no rules to follow; the slipmaker had to use his judgment after observing the results of the cup test. It must be understood that the viscosity did vary, but the range was small, and the aim in keeping it comparatively constant was merely to prevent trouble from leaking molds or making the pump labor, the casters drawing their slip from a circulating system and not from a tank.

VAN BRIGGLE TILE AND POTTERY CO.
COLORADO SPRINGS, COLO.

TRANSVERSE STRENGTH OF BALL CLAY-SAND AND BALL CLAY-FLINT MIXTURES[1]

By L. P. Collin[2]

ABSTRACT

Tests of dry transverse strength on 30 ball clays using mixtures of 50% ball clay + 50% flint, and 50% ball clay + 50% standard silica sand, which demonstrate the method adopted as a tentative standard and which specify the use of silica sand as the nonplastic, are unsatisfactory for determining the dry transverse strength of highly plastic clays. More consistent results were obtained with flint as the nonplastic.

Introduction

Bodies were produced with insufficient bonding power in an investigation being carried on in the Mines Branch laboratories. As the clay content was already high it was thought that a more plastic ball clay should be used. Tests were made of the transverse strength of the English ball clay which had been used and a very plastic Saskatchewan ball clay according to the Tentative Standard as adopted by the American Ceramic Society. The results were surprising. The test bars of the Saskatchewan ball clay had a strength of less than 100 pounds per square inch, whereas its working properties indicated that its bonding strength should have been much higher than that of the English ball clay. The surface of the test bars was covered with a network of cracks around the sand grains, easily seen with the naked eye. The high shrinking of the clay around the coarse grains of sand was responsible for this cracking. These cracks were present throughout the body.

When Professor Worcester[3] showed the extremely high bonding power of the Saskatchewan clays, it was decided to determine the fitness of the standard bonding test[4] as applied to representative ball clays of different types.

While a considerable amount of work has been published on this subject, very little has been done to show the differences in results obtained by using a coarse nonplastic and a fine nonplastic. The one notable exception to this is the work of Bleininger and Howat.[5]

Watts[6] states "a mixture of 50% by weight clay and 50% by weight

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[1] Published with the permission of the Director, Mines Branch, Department of Mines, Ottawa, Canada. Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division). Received June 25 1930.

[2] Ceramic Engineer, Mines Branch, Dept. of Mines, Ottawa, Canada.

[3] "Investigation of Twenty-One Saskatchewan Ball Clays," *Jour. Amer. Ceram. Soc.*, **12** [5], 360–81 (1929).

[4] *Jour. Amer. Ceram. Soc.*, **11** [6], 460–61 (1928).

[5] *Trans. Amer. Ceram. Soc.*, **16**, 271–83 (1914).

[6] *Jour. Amer. Ceram. Soc.*, **3** [3], 250 (1920).

nonplastic (potters' flint recommended) gives a reliable and satisfactory means of indicating the bonding strength of the clay." Worcester[7] used potters' flint as the nonplastic and obtained satisfactory results.

There is no doubt that mixtures of sand and clay will shrink and deform less than mixtures of potters' flint and clay, but as sand has caused cracking during the drying of certain highly plastic clays, it was determined to compare the effect of sand and potters' flint directly as nonplastics.

Procedure

Representative samples of clay from England, the United States, and Canada were obtained for a series of tests. The clays were thoroughly dried between 64°C and 76°C, crushed, and screened to pass a No. 20 sieve. Ten-pound batches were made using 50 clay + 50 standard silica sand (20- to 30-mesh) in one case, and 50 clay + 50 potters' flint in the other. The screen analysis of the potters' flint was as follows:

	Sieve No.	Per Cent
On	100	
"	150	0.10
"	200	2.19
"	270	65.31
Through	270	32.35
		99.95

Preparation of Mixtures The clay and nonplastic were thoroughly mixed dry, tempered with water to soft plastic consistency, thoroughly wedged, and allowed to age for 24 hours, and again wedged.

Molding of Test Pieces A brass mold was used, 1 by 1 by 8 inches. Throwing the mixture forcibly into the mold as recommended in the Standard Test Method was impracticable because entrapped air prevented satisfactory filling of the mold.

The wedged clay was cut into bars of a length and width slightly smaller than the mold but of greater depth. The clay was forced into place by hand, beginning at the middle and working to the ends, then back and forth until the mold was completely filled. The excess material was struck off with a wire and the surface smoothed with a spatula. The bars were numbered before removing from the mold. Twenty bars were made of each mixture. The drying was carried out in accordance with the method given in the AMERICAN CERAMIC SOCIETY Tentative Method.

Testing Ten bars of each mixture were broken with the load applied at the rate of 100 pounds per minute, and ten at 50 pounds per minute. After each break, careful measurements were made of the cross-section of the bar and observations were made as to the internal structure

[7] *Loc. cit.*

and character of the fracture. An average was made of the moduli from each set of bars, deviations from this average greater that 15% were struck out, and a new average was calculated from the moduli of the eight or nine remaining bars.

The machine used was the latest model Olsen-Boyd Automatic Cement Tester equipped with a special tool. The load was applied by means of a suspended weight governed hydraulically and set in motion by releasing a latch. The rate of descent of the weight and consequently the rate of application of the load may be regulated hydraulically by a valve at the bottom of the vertical cylinder. The load was indicated on a dial.

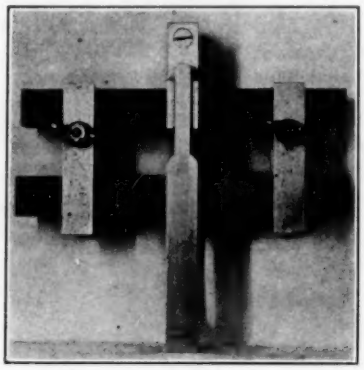

FIG. 1.—Transverse tool.

The transverse tool had features which simplified centering of the bar (Fig. 1). This upper knife edge was held at a constant center by sliding through grooves in the piece supporting the lower knife edges. A scale was cut into this supporting piece and the standards of the lower knife edges were slid along this scale and clamped at any desired span by wing nuts. Thus, once the tool is set with the

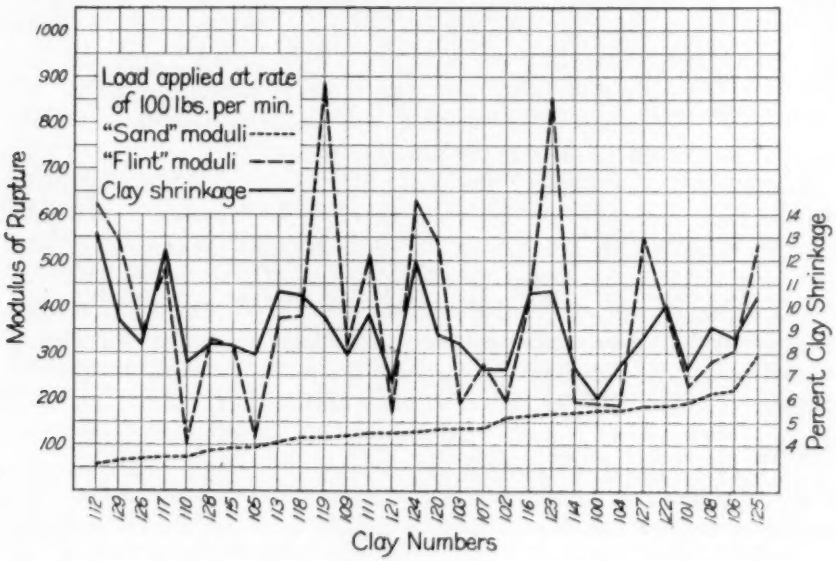

FIG. 2.—Clay numbers arranged from low to high clay-sand moduli (100 lbs. per min.),

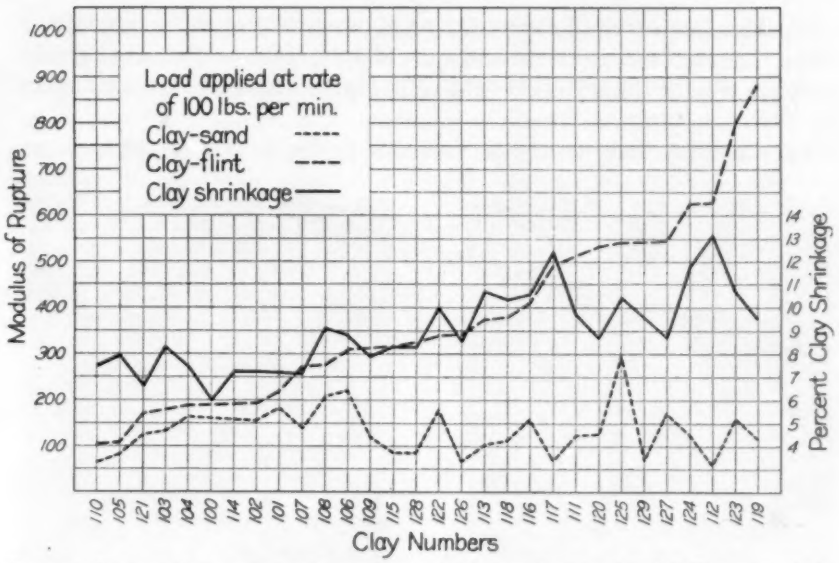

FIG. 3.—**Clay numbers arranged from low to high clay-flint moduli (100 lbs. per min.).**

proper span the test piece is simply slid into place and no further centering is required.

The simplicity of this machine and the fact that the knife edges are automatically centered and held parallel to one another permitted the bars to be placed in position much more rapidly and much more accurately than in the old type automatic shot machine.

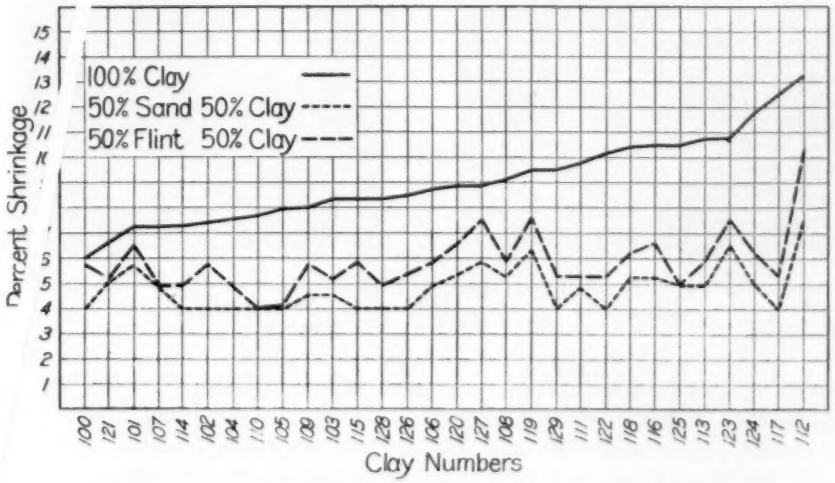

FIG. 4.—**Clay numbers arranged from low to high clay shrinkage.**

Cracking had occurred during drying in practically every bar containing sand. In many cases these cracks were plainly visible. These fine cracks were not only on the surface (as shown in Fig. 5) but throughout the entire structure (as shown in Fig. 6).

The clay-flint bars showed no evidence of drying cracks but in many

FIG. 5.—Surface of clay-sand bar (×15 approx.).

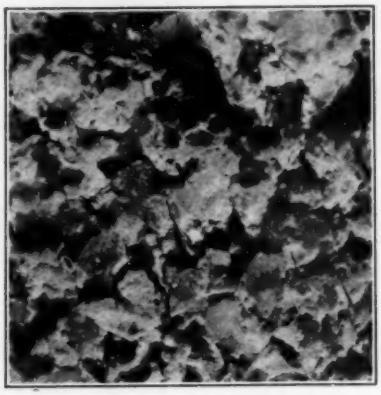

FIG. 6.—Cross-section of clay-sand bar (×15 approx.).

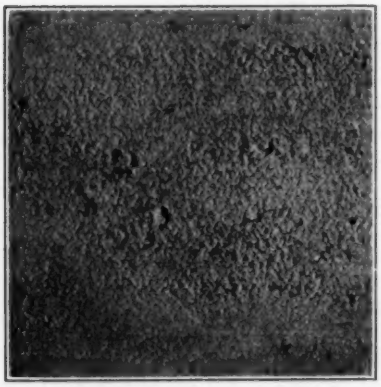

FIG. 7.—Surface of clay-flint bar (×15 approx.).

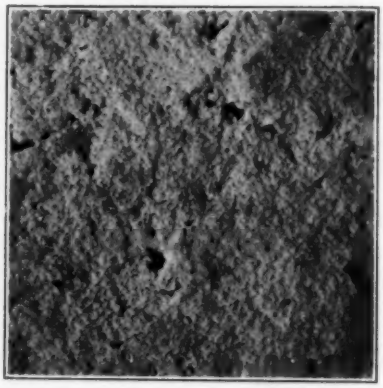

FIG. 8.—Cross-section of clay-flint bar (×15 approx.).

cases had small voids (Figs. 7 and 8). These bars had more diagonal breaks than those of the clay-sand mixtures. This might be due to the higher load at which the breaks occurred. Neither the air holes, however, nor the diagonal breaks gave any indication of affecting the modulus of rupture in any of the tests made.

The tests with the load applied at 50 lbs. per minute were made to ascertain whether a slower rate of load application than that specified would make any material difference in the moduli obtained. Tables I and II show that the differences in moduli were, for the most part, negligible. Deviations from the averages indicated that a slower rate of load application would give more consistent results, but as the differences were not

TABLE I

MODULUS OF RUPTURE (LOAD APPLIED AT RATE OF 100 LBS. PER MIN.)

		Clay-Sand					Clay-Flint				
Clays	Sample No.	Av.	Max.	Above av. (%)	Min.	Below av. (%)	Av.	Max.	Above av. (%)	Min.	Below av. (%)
English	100	170	191	12	151	11	190	217	14	175	9
	101	186	211	13	173	10	219	237	8	206	6
	102	156	170	9	136	13	194	216	10	174	10
	103	137	144	4	125	9	181	203	10	156	14
American	104	170	178	5	153	10	189	194	3	178	6
	105	86	89	3	79	8	108	111	4	105	3
	106	222	239	8	211	5	306	324	6	291	5
	107	141	158	12	123	13	276	309	12	263	5
	108	210	226	8	199	5	280	293	5	265	5
	109	121	136	13	107	11	307	336	9	287	7
	110	70	73	4	64	9	102	109	7	95	7
Canadian	111	124	130	5	116	7	517	552	6	470	9
	112	52	55	6	47	8	634	643	1	603	5
	113	102	106	4	97	5	376	420	12	344	9
	114	165	189	15	145	12	193	204	6	181	6
	115	85	89	5	82	3	312	340	8	266	15
	116	161	166	3	151	6	419	485	15	404	4
	117	68	71	4	60	12	495	528	7	448	9
	118	114	123	12	105	7	380	431	13	328	14
	119	115	127	10	99	14	893	1000	12	801	12
	120	137	153	12	127	7	538	617	15	470	13
	121	125	140	12	106	15	171	195	14	146	14
	122	185	193	4	179	3	340	380	12	308	9
	123	162	173	7	144	11	792	820	11	732	8
	124	126	131	4	114	10	628	723	14	540	14
	125	299	341	14	259	13	546	585	10	493	8
	126	66	70	6	57	14	343	393	15	326	5
	127	180	201	12	164	8	551	573	5	525	5
	128	84	92	10	75	10	322	354	13	282	10
	129	65	73	13	59	9	548	575	5	486	11

great no definite conclusion should be drawn. The graphs (Figs. 2, 3, and 4) show the results of the tests.

Conclusion

The results obtained with this series of thirty representative ball clays definitely prove that sand when used as the nonplastic does not give a true indication of the dry transverse strength. Clays having working properties and physical characteristics, which mark them to be among the strongest of the series when mixed with 50% of standard silica sand, have a modulus which would place them among those clays whose working properties and physical characteristics definitely mark them as the weakest of the series.

Furthermore, the narrow range between the lowest and highest clay-sand modulus as compared with the wide range of the clay-flint moduli does not permit the proper allocation of clays in reference to their dry transverse strength. In addition, the use of any nonplastic which causes numerous drying cracks to appear throughout the structure of test bars should not be considered in any tentative test.

TABLE II

MODULUS OF RUPTURE (LOAD APPLIED AT RATE OF 50 LBS. PER MIN.)

		Clay-Sand					Clay-Flint				
Clays	Sample No.	Av.	Max.	Above av. (%)	Min.	Below av. (%)	Av.	Max.	Above av. (%)	Min.	Below av. (%)
English	100	176	198	11	151	14	205	227	11	185	10
	101	198	222	12	169	15	246	260	6	214	13
	102	147	161	10	136	7	174	201	15	152	13
	103	143	211	10	126	12	188	204	12	165	12
American	104	152	169	11	141	7	176	195	13	152	14
	105	91	104	14	80	13	134	151	13	121	10
	106	225	248	11	194	14	280	298	6	259	8
	107	165	173	5	144	12	291	332	14	250	14
	108	208	225	8	196	6	297	336	13	255	14
	109	140	144	3	124	10	247	261	6	235	5
	110	78	84	8	74	10	104	112	8	100	4
Canadian	111	124	131	6	117	6	472	521	10	431	9
	112	66	75	14	62	6	617	669	8	576	7
	113	96	105	9	88	8	419	449	7	401	4
	114	158	180	14	139	12	169	184	9	143	15
	115	72	81	13	64	11	355	385	9	340	4
	116	118	135	11	95	11	512	576	12	446	13
	117	74	80	8	63	15	452	520	15	399	11
	118	102	108	6	95	6	483	550	14	418	13
	119	119	127	7	109	8	859	993	15	785	10
	120	129	143	11	122	5	532	595	12	456	14
	121	131	143	9	120	8	165	189	15	149	9
	122	161	189	18	141	12	341	377	11	308	10
	123	224	252	13	201	10	767	877	14	678	12
	124	128	131	3	122	4	633	729	15	565	11
	125	294	319	9	266	10	386	446	15	345	11
	126	69	79	15	64	7	379	394	4	349	9
	127	184	204	15	159	10	592	616	8	543	8
	128	80	84	6	77	3	344	370	8	298	13
	129	63	69	10	54	14	363	385	6	352	3

The results obtained when potters' flint was used as the nonplastic were quite satisfactory in every way. The clays with working properties and physical characteristics which mark them as having a high bonding power actually have a high transverse strength. While not holding true in every case, the shrinkage curves and moduli are similar, the moduli increasing as the clay shrinkage increases. The most notable exceptions to this are clays which have an unusually high modulus and this must be attributed to some other physical characteristics than that indicated by shrinkage.

The wide range between the highest and lowest clay-flint modulus facilitates the placing of clays in order of their true strength, whereas

the narrow range of the clay-sand moduli makes such placing very uncertain.

The drying of clay-flint test bars offers no difficulties if the drying method prescribed in the tentative test is carried out. No trouble was encountered in this investigation with extreme warpage and practically none of the clay-flint bars showed any evidence of drying cracks.

The use of a finely ground nonplastic makes the test conditions much closer to actual conditions of use as in whiteware bodies and for this reason, if for no other, the use of potter's flint is desirable.

The differences shown to exist between results obtained with the rate

TABLE III

PER CENT SHRINKAGE

Sample number	100% clay	50% clay 50% sand	50% clay 50% flint	Sample number	100% clay	50% clay 50% sand	50% clay 50% flint
100	6.0	4.0	5.7	115	8.3	4.0	5.7
101	7.2	5.7	6.6	116	10.5	5.3	6.6
102	7.3	4.0	5.7	117	12.5	4.0	5.3
103	8.3	4.5	5.2	118	10.4	5.3	6.2
104	7.4	4.0	4.9	119	9.5	6.2	7.5
105	7.9	4.0	4.0	120	8.7	5.3	6.6
106	8.7	4.9	5.7	121	6.6	5.1	5.2
107	7.2	4.9	4.9	122	10.1	4.0	5.3
108	9.1	5.3	5.7	123	10.7	6.6	7.5
109	7.9	4.5	5.7	124	11.9	4.9	6.2
110	7.5	4.0	4.0	125	10.5	4.9	4.9
111	9.7	4.9	5.3	126	8.5	4.0	5.3
112	13.2	7.5	10.3	127	8.7	5.7	7.5
113	10.7	4.9	5.7	128	8.3	4.0	4.9
114	7.2	4.0	4.9	129	9.5	4.0	5.3

of load application at 50 lbs. per minute and at 100 lbs. per minute, even though they were not great, should make this worthy of further work.

Another condemnation of the tentative test is that practically no one uses it. The figures obtained by clay-miners and dealers give evidence that they do not use clay-sand mixtures. Papers written by various investigators since the tentative test was adopted show that practically none of them use clay-sand mixtures. Discussions of papers as well as comment on testing by many of the leading technologists give evidence that the test is not satisfactory either with the use of sand as the nonplastic or with the method of forming the test bars. The results obtained in this investigation simply give definite evidence to support the general opinions which exist at the present time.

The following suggestions are made for revising the tentative method of testing dry transverse strength:

(1) That a fine nonplastic (preferably potters' flint) be used in place of standard silica sand.

(2) That a method of forming the test bars be changed to one that is practicable.

(3) That further consideration be given to the rate of application of the load.

OBSERVATIONS OF CAUSES FOR INCONSISTENT RESULTS IN COMMERCIAL FINENESS TESTS OF PORCELAIN ENAMELS[1]

By H. G. Wolfram

ABSTRACT

Results are given of commercial tests showing inconsistencies in results obtained. Investigation proved these differences to be due to careless manipulation, clogging of screen openings in the original cloth as manufactured, and distortion of the mesh in fastening the cloth to the frame.

Introduction

The test-sieve method for controlling the fineness in milling enamels is helpful. It is a part of the regular procedure in every well-regulated shop. There are several deviations from the Standard adopted by the Enamel Division of the American Ceramic Society, and it is believed that if the proper precautions are taken, these are just as effective in the ultimate result. These deviations were introduced as short cuts and as a means of saving the cost of high-priced apparatus.

One of the short-cut methods prescribes a 150-mesh sieve and measuring both the enamel slip and residue in calibrated measures rather than by weighing them. The sieve is so designed that the screen wire can easily be removed and a new wire soldered into place. The present cost of standard sieves and the short life of screen wire makes such a design very desirable.

The Investigation

Purpose The wire cloth first used was monel wire; complaints, however, were received that the new screens did not check with the old, some of the differences being as high as 15 grams on the same mill of enamel. It was found that these complaints were well founded, but the results obtained checked with those of H. L. Cook.[2]

Method A rotary screen shaker was installed and Cook's recommendations were adhered to. In the laboratory tests for fineness, the enamel slip and residues were weighed with tolerances within 0.1 gram. A large mill of enamel was set aside as a standard sample for checking sieves. Fineness tests were made using this enamel on three standard sieves from three different reliable sieve manufacturers. A Bureau of Standards certified 150-mesh test sieve was purchased and checked against the sieves on hand. One of these passed within what was thought to be a fair tolerance and two were rejected.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

[2] "A Method for Testing the Fineness of Porcelain Enamels," *Jour. Amer. Ceram. Soc.*, **12** [9], 566–69 (1929).

Tolerances The certified sieve then was set aside as standard and the enamel, which was ground to 6 grams, was set aside as a standard sample. This fineness is the weight of residue remaining on a 150-mesh sieve after thoroughly washing a 100-gram sample on the sieve, drying, and shaking for seven minutes on the rotary sieve shaker. The tolerance chosen for the selection of sieves was ±0.5 gram deviation from the standard.

Method of Check The cloth was soldered to the frame as if ready for use in the mill room. Three 100-gram samples of the standard enamel were accurately weighed. One at a time these samples were washed onto the sieve, dried, shaken, and weighed. The three results were averaged and the resultant average compared with the standard. If this weight was within ±0.5 gram, the sieve was accepted.

Selection of Wire Ordinary 150-mesh monel screen cloth was used on the small test sieve, a number of which were in stock and checked against the standard. These sieves deviated too far from standard and from the tolerances. Bronze wire such as is used on standard 8-inch sieves was purchased in one piece and cut into blanks to fit the frames. The cost of this wire was considerably more than the monel and it varied within each piece as purchased; different shipments also varied from each other. These difficulties were overcome by specially selected blanks six inches square. This size was the proper dimension for soldering to the frames.

Results Thus the difficulties were practically overcome. Every sieve made for use in fineness tests was first standardized before use. The following table is a sample of the record kept for each sieve as it was tested.

TABLE I

RESULTS OF SIEVE TESTS WITH VARIOUS SIEVES ON STANDARD SAMPLE

(Tolerance of acceptance 0.5 gram on average)

Sieve No.	1st Test	2nd Test	3rd Test	Average	Result
Standard	6.3	6.0	6.3	6.2	
14	6.6	5.7	6.5	6.2	O.K.
17	7.9	6.5	7.8	7.0	re
24	5.8	6.1	5.9	5.9	O.K.
33	6.2	5.5	6.0	5.9	O.K.
35	6.5	5.7	6.0	6.1	O.K.
38	5.8	5.8	6.0	5.9	O.K.
40	5.8	5.7	5.8	5.8	O.K.
43	5.7	5.7	6.2	5.9	O.K.
45	6.0	6.2	6.2	6.1	O.K.
49	6.6	6.2	5.8	6.2	O.K.
50	7.2	6.5	8.2	7.3	re
57	5.8	5.7	5.9	5.8	O.K.
58	7.0	6.8	6.6	6.8	re
59	3.6	4.2	3.7	3.8	re
60	10.2	6.8	9.4	8.8	re
61	6.5	6.1	6.5	6.4	O.K.
62	6.0	6.0	6.1	6.0	O.K.

Conclusions

The conclusions drawn from this study are as follows:

(1) It is necessary, in order to obtain the proper results in fineness tests, to use selected wire cloth or sieves.

(2) Great care should be exercised in soldering sieve cloth to frames so as not to distort the wire meshes.

(3) It is necessary to retain a standard sieve and a standard sample to check and calibrate new cloth or sieves.

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A COMPARISON OF RESULTS OBTAINED WITH AN IMPACT MACHINE[1]

By Richard H. Turk

ABSTRACT

A description is given of an impact machine having a pendulum of rigid design. An instantaneous mechanical release is used, eliminating the human element. Results of tests with this machine are given, showing the probable consistency of such a machine.

Introduction

The results given in this paper were obtained on an impact machine, the same in principle as that used by the Bureau of Standards for determining the impact and chipping resistance of chinaware.

The original machine as used by the Bureau[2] was found to be of insufficient power to test present-day enameled ware. The machine at the stage to which it was developed at the time the machine described in this paper was designed, was crude and lacked many features desirable for continuous and hard usage, and an experienced operator was necessary to obtain fairly consistent results.

Little attention has been given to impact tests on enamels. Laboratories have been content to strike enameled surfaces with some hard object or to strike two enameled pieces together. These methods are almost worthless.

Description of Machine

In the fall of 1926, an impact machine was designed and built incorporating as many refinements as possible. A study of Figs. 1, 2, and 3 will give a general idea of the appearance and construction of the machine.

It has a pendulum arm two feet in length, carrying a weighed hammer or bob. The arm is kept rigid by a system of guy wires, and is fastened to a short shaft turning in ball bearings. The ends of the shaft are turned to a point and hardened. The caps at the ends of the bearing boxes are hardened and are just brought in contact with the pointed ends of the shaft to take up end play. Friction is negligible, as the bearing surface is very small. By stiffening and suspending the pendulum as described, each blow is delivered at the same place upon the test piece.

The release mechanism slides on two quadrants, graduated so as to give blows in increments of 0.05 foot-pound with the one-pound hammer. A catch engages notches in the quadrants, holding the release device. A forked hook engages the cross-bar on the pendulum arm and holds the

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division). Returned for revision and received April 10, 1930.

[2] Staley and Hromatko, *Jour. Amer. Ceram. Soc.*, **2**, 227 (1919); "Comparative Test of American and Foreign Tableware," *Jour. Amer. Ceram. Soc.*, **5** [6], 276 (1922).

pendulum until released by tripping a spring which causes the hook to snap back.

Two hammers are used, weighing one and two pounds, respectively. They are pear-shaped and have a hardened striking face of 1-inch radius. By changing hammers, blows equivalent to four foot-pounds, as a maximum, can be delivered. The two-pound hammer is used mostly for cast-iron enamels and the one-pound hammer is used for sheet-iron enamels.

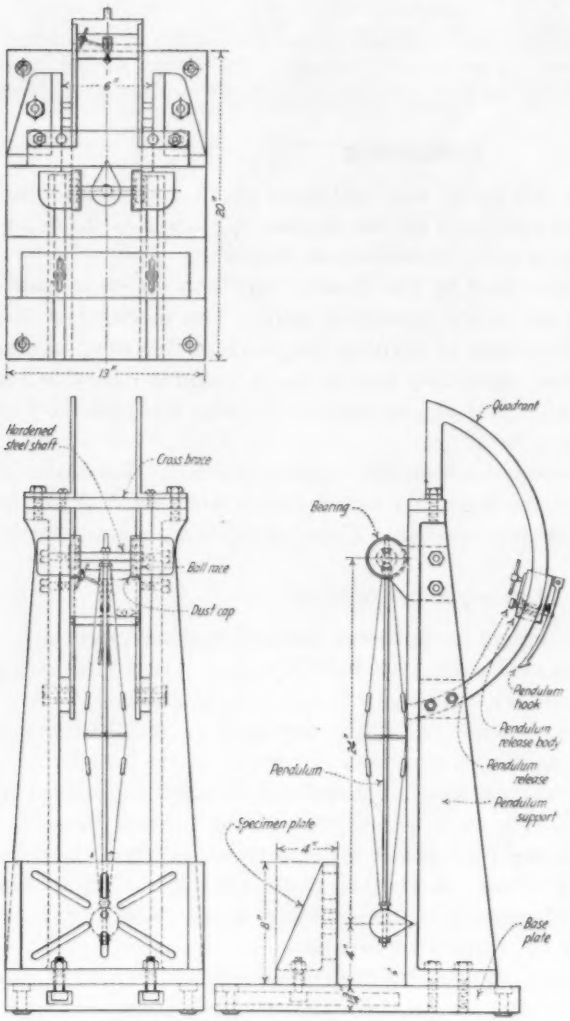

FIG. 1.

The standards are heavy, rigid castings, as is the base of the machine. A heavy cast-iron angle plate slides in a milled slot in the base and is adjustable along the length of the machine to take care of samples of varying depth. A hole is drilled into the angle plate in line with the hammer when it hangs free to facilitate observation of failure of sheet-iron samples.

All castings are extra heavy to assure a rigid, vibration-free machine; leveling screws are in the base. Clamps are built into the angle plate and are so designed as to take care of almost any shaped sample.

The gross weight of the machine is about 275 pounds, and it was built at

a cost of about $425.00. Duplicate machines would cost considerably less.

Graduation of Machine

The weight of the pendulum of this machine when constructed as specified is four ounces. As the arm is symmetrical in form its weight can be considered as concentrated at the middle point. Therefore the following formula is applied:

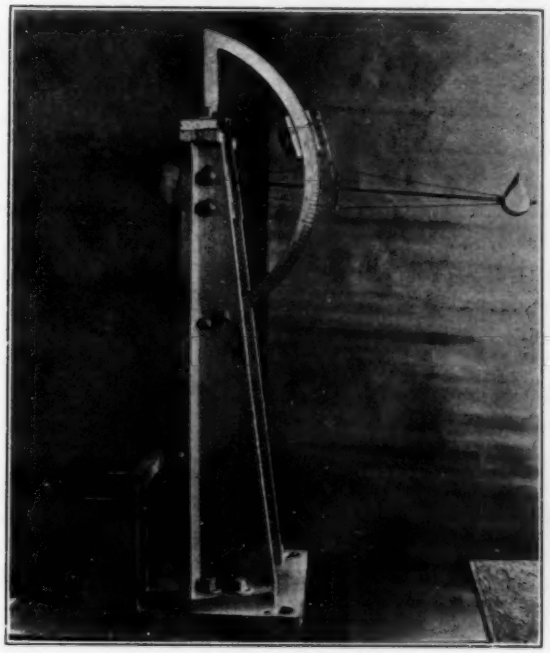

FIG. 2.

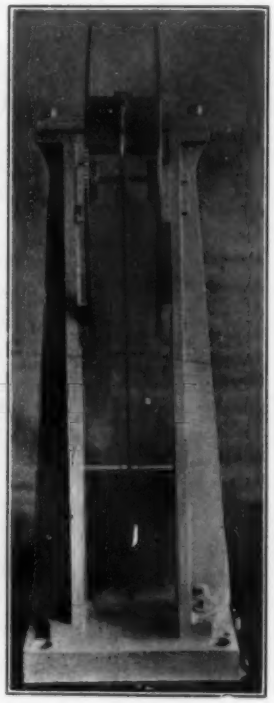

FIG. 3.

$$H = \frac{I}{W + \frac{w}{2}}$$

Where H = height of hammer
I = impact in ft.-lbs.
W = weight of hammer (lbs.)
w = weight of arm (lbs.)

From the point of contact of the height, H, and an arc described by the hammer, a line is projected to the center of the bearing shaft. The quadrants are graduates where this line crosses them.

Method of Making Tests

Sheet-iron enamels were tested by applying them upon small rectangular trays of 20-gage enameling iron, $7^1/_8$ inches long, $4^3/_4$ inches wide, and $^7/_{16}$ inch deep. The sides were turned up through a curve of $^1/_2$-inch radius. Cast-iron enamel was tested by applying it to small rectangular castings 6 inches long, $3^1/_2$ inches wide, and $^1/_8$ inch thick. These castings have a slight panel effect; they have a bow of $^5/_{16}$ inch in the middle.

The enamels were applied according to the recommended weights, fineness, and firing temperatures, and were milled according to recommended mill formula.

Samples were securely clamped onto the angle plate and the plate was adjusted so that the pendulum, when hanging vertically, just touched the face of the sample.

Sheet-iron samples were placed on the angle plate so that the hammer struck the bottom of the tray in accordance with the original recommendation of the Bureau of Standards.[3] The reverse side of the sheet-iron sample was turned toward the pendulum so that the sample could flex slightly to prevent crushing the enamel, simulating the type of blow to be expected in actual service. Cast-iron samples were placed face outward, the blow being received upon the enameled surface. In service, there was no flexing of cast iron, so the enamel was tested under rigid conditions. Samples had to be square against the angle plate so that they could not move or chatter when the blow was delivered. Samples were placed so that the hammer struck in the middle. Ten samples were used and the average of such a set was considered the impact resistance of the enamel.

The pendulum was brought back to the release mechanism which was set at the lowest graduation, and, when at rest, released. After striking the sample, the pendulum was caught before it struck a second blow and was released from the next point of graduation.

After each blow the hammer was caught and released one graduation higher until failure of the sample. Failure was accepted when the enamel was broken away from an area one quarter of an inch in diameter. The position of the release mechanism on the quadrants at the time of failure was taken as the impact resistance.

If the two-pound hammer was used, the readings had to be doubled.

Results

The results obtained with sheet-iron samples are shown in Table I.

These enamels were regular sheet-iron cover-coat enamels of different manufacture. Enamel D gave a peculiar run. Whether this was a freak or due to exact duplicates of samples could not be determined.

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[3] R. R. Danielson and B. T. Sweely, "The Relation between Composition and Properties of Enamels for Sheet Steel," *Jour. Amer. Ceram. Soc.*, **6** [10], 1011–29 (1923).

A study of the figures reveals that a good majority of the results are within close relation. Those that deviate greatly may be considered freak cases, rising from a number of causes.

Regular ground coats cannot be satisfactorily tested for impact, though good results can be obtained on single-coat enamels

TABLE I

SHEET-IRON ENAMELS

Test Number	Enamel A	B	C	D	E	F
1	1.80	1.85	2.0	2.0	1.65	2.2
2	1.85	1.85	2.2	2.0	1.55	2.2
3	2.00	1.8	2.2	2.0	1.70	2.1
4	1.80	1.8	2.4	2.4	1.65	2.1
5	1.75	1.8	1.85	2.0	1.70	2.1
6	1.75	1.9	1.80	2.0	1.55	1.9
7	1.80	1.85	1.85	2.0	1.55	1.9
8	1.90	1.85	1.85	2.0	1.75	2.0
9	1.85	2.0	2.4	2.0	1.75	2.2
10	2.00	1.85	2.0	2.1	1.60	2.3
Average	1.85	1.85	2.05	2.0	1.64	2.1

No. F, is a single-coat enamel (white ground)

Table II shows the results obtained on cast-iron enamels. Readings on an average run much higher than sheet-iron enamels and must be made with the two-pound hammer. The majority of the wet-process cast-iron enamels gave a distinct end-point, though some would suddenly flake off in large pieces without warning. Dry-process enamels all chipped badly at failure, sometimes breaking away to the ground coat only and then again some exposing the iron.

TABLE II

CAST-IRON ENAMELS

Test Number	Enamel A	B	C	D	E	F	G
1	2.4	2.3	2.6	2.1	2.4	2.2	2.4
2	2.6	2.3	2.2	2.1	2.4	2.5	2.0
3	2.4	2.2	2.2	2.0	2.4	2.0	2.8
4	2.6	2.5	2.2	2.0	2.7	2.1	2.4
5	2.8	2.5	2.5	2.3	2.6	2.3	2.0
6	2.5	2.2	2.3	2.4	2.4		2.2
7	2.7	2.1	2.2	2.1	2.6		
8	2.6	2.1	2.0	2.0	3.0		
9	2.8	2.5	2.2	2.4	2.4		
10	2.9	2.5	2.3	2.1	2.9		
Average	2.65	2.32	2.27	2.15	2.58	2.25	2.3

Nos. F and G are dry-process enamels. Failure resulted in large chips.

To determine the effect of sample shape upon results, several different kinds of stampings were enameled and tested. Results are shown in Table III.

All of the samples used for results in Table III were prepared at one time from the same milling of enamel. From the results obtained, it is clear that the type of test pieces and the gage of the metal will have great effect

TABLE III

IMPACT RESULTS ON VARIOUS SHAPES

Test Number	Enamel A	B	C	D	E
1	0.65	1.75	1.2	1.05	
2	0.65	1.75	0.95	1.0	
3	0.7	2.00	1.3	0.9	
4	0.6	1.75	1.05	1.0	
5	0.65	1.70		1.0	
6	0.65	1.75		1.0	
7	0.75	1.90		1.0	
8	0.6	1.95		1.1	
9	0.6	2.00		1.0	
10	0.6	2.00		0.95	
Average	0.64	1.85	1.1		

A Saucepan $6^3/_4$ in. diam. by $1^1/_{16}$ in. deep (26 gage)
B Standard sheet-iron test trays (20 gage)
C Square pan 6 in. square by 2 in. deep (24 gage)
D Dinner plates $9^5/_{16}$ x $^3/_4$ in. (26 gage)

upon results obtained. Readings on an average run fairly uniform for any particular shape.

An effort has been made to tie up some of the variations in results with lack of uniformity in gages, spraying, and firing, but there has not been sufficient work done to justify any conclusions at this time. It is obvious that variations in the thickness of metal and enamel will cause irregularities and undoubtedly slight differences in firing have a decided effect upon results.

To determine the reliability of the old method of hand-testing enamels for impact, ten stove legs were enameled with the same enamel and with as much care as possible to have them all alike. While holding one casting still, it was struck a sharp blow with another of the legs, the points of con-

TABLE IV

Test Number	Casting in Motion	Casting Still
1	Surface crushed	Chipped $1^1/_2$ inch diameter
2	" "	Chipped about 1 inch diam.
3	Chipped $^1/_2$ inch diam.	" " 1 " "
4	No effect	" " 1 " "
5	Chipped about 1 inch diam.	" " 2 " "
6	" " 1 " "	" " $^1/_2$ " "

tact on both being the same. The enamel on the casting that was still was chipped off in a big spot and the casting which was in motion showed only a slightly crushed surface. The results of a series of these tests are shown in Table IV.

It will be observed that the casting not in motion always received the most damage and that while the casting in motion in some cases was damaged, failure never was greater than on the stationary casting. This same test was made using an enamel which proved weak on the impact machine on the casting in motion, striking enamels of higher impact test and the same general results were obtained as indicated in the preceding Table III.

False results will be obtained by striking an enameled surface against a hard object. The enamel may show an almost ridiculous resistance to impact, whereas if the enameled surface were struck with the hard object, the enamel would seem to be very poor.

Conclusions

(1) It was found that a machine of sturdy design and able to deliver a blow equivalent to 4 foot-pounds is desirable for consistent impact figures for sheet- and cast-iron enamels.

(2) It is believed that if reasonable accuracy is used in preparing samples, consistent results will be obtained.

(3) It was determined that the old method of testing the impact resistance of an enamel by striking it against or with a hard object is no exact test and is misleading and inconsistent.

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THE DEVELOPMENT AND USE OF A SIMPLE CONSISTENCY PIPETTE FOR USE IN THE ADJUSTMENT AND CONTROL OF ENAMEL SLIPS[1]

By C. J. Kinzie and C. H. Commons

ABSTRACT

A metal consistency pipette is described and some details relative to its development and use are given.

Introduction

In adjusting enamel slips to a suitable consistency for dipping or spraying, we used for several years an ordinary 50 cc. glass pipette with a fine tip cut back so as to have a larger opening. This simple instrument proved fairly satisfactory for coarse adjusting of draining slips and was entirely satisfactory for all spraying operations.

It was suggested that a practical plant consistency control instrument be made by cutting off the glass tip of a 100 cc. pipette to expose the full diameter of the lower tube and attaching a metal tip. A monel metal tip was machined to slip loosely over the glass tube, having a 2.95 mm. orifice.

This instrument worked well as a consistency control instrument in milling and spraying departments of an enameling plant and gave satisfactory service in various places, but the glass parts were occasionally broken; and with attempts to duplicate the glass pipettes our troubles began.

Having the main body of the pipette of glass was a great advantage in simplicity of manufacture and operation, but it was finally determined that an instrument of glass having the shape of the usual pipette was impractical for the reason that it seemed impossible to have these produced of sufficiently uniform size.

The Design Finally Adopted

Seamless brass tubing was obtained in various sizes having a uniform bore. After preparing and testing several experimental brass instruments the following design was perfected.

The brass tube body and the tip is one piece and the mouthpiece of heavy wall Pyrex glass tubing with the threaded brass plug is another piece.

A mark is placed on the glass mouthpiece $14^{7}/_{8}$ inches from the tip or outlet of the pipette. The bore of the tip is $^{9}/_{64}$ of an inch which appears to answer well for spraying enamel control, although this could of course be varied to suit the case.

A gasket is fitted to the top piece to make an air-tight seal.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

Use of Pipette

This consistency pipette does not, of course, give the information which can be obtained by means of a plasticimeter and is only suggested as a rapid means of simple consistency control in cases where the main variable in compounding the slip is that of water content. The instrument has been used for plant control purposes both in the milling and in the spraying departments quite satisfactorily.

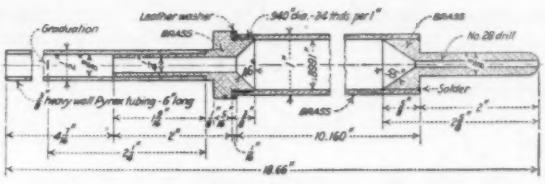

FIG. 1.

No difficulty has been encountered in machining brass tubing to dimensions and having the metal part of predetermined capacity from the bottom of the tip to the top of the small brass tube on the cap. The only variable would be in the differences in glass tubing but this is negligible, due to the fact that the mark on the glass is purposely placed near the top of the smaller brass tube.

The accompanying drawing indicates the structural details of the instrument.

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METHODS FOR THE DETERMINATION OF THE FIRING RANGE OF VITREOUS ENAMELS USED IN WET-PROCESS ENAMELING[1]

By C. J. Kinzie

ABSTRACT

Several methods for making firing range studies in case of wet-process enamels are described. The methods used in producing enamel deposits of predetermined weights are given. The use of these methods has shown that enamels used in wet-process enameling of metal vary widely in action under various conditions of heat and a general discussion of the subject is included.

Introduction

The cone deformation point method which has been found to give excellent results on enamels and glasses in determining the softening range of these cannot, however, be used with any degree of success with mixtures of glass, clay, and opacifier as used in wet-process enameling. Each of two methods has been used at various times to determine the firing range, stability under heat, and other characteristics of wet-process vitreous enamels.

Firing Range Method No. 1

In comparing an enamel of unknown properties with a standard enamel for firing range by this method, two flat pieces of iron enameled in ground coat are selected; these should be same in size, gage of metal, and weight. Pieces $6^3/_8$ x $6^3/_8$ inches were used for this test.

Each piece is weighed and one piece is coated with the standard enamel and the other is coated with the test enamel, having each enamel deposited at the rate of 0.17 gram dry enamel per square inch.

The furnace used for firing has in the back some object such as a nichrome bar in such a position that when the enamel is matured to a luster a sharp image will appear on the enamel surface.

The furnace temperature is adjusted to 1650°F and one of the test pieces is placed and time noted by a stop-watch. When the enamel has matured and the image is sharp the time is noted and the piece is removed. The other test piece is treated in the same manner at 1650°F, in each case recording the time required to come to luster at this temperature.

The furnace temperature is lowered to 1600°F.

Each piece is given a second coating of enamel of the same weight as the first coat and each is fired to luster at 1600°F, noting the time required as before.

For each enamel, this operation is repeated in decreasing temperature steps of 50°F each until for each enamel a temperature is reached at which the enamel fails to come to luster in five minutes.

[1] Received July 3, 1930.

By a comparison of the behavior of each enamel as shown by the time required at the various temperatures valuable information can be obtained and a fairly accurate prediction can be made as to how the unknown enamel might be expected to behave in the plant.

This method has the advantage that for each test only one piece is used and the disadvantage that no permanent enameled specimens are obtained. The method therefore, is, so far as permanent records are concerned, only one for firing range, although some information can be obtained by observing the character of the enameled surface after each firing.

Firing Range Method No. 2

This method has been extensively used in the laboratories in cases where it is important to have permanent enameled specimen records, illustrative of the action of various enamels at different temperatures.

This method has the advantage over method No. 1 in that the standard enamel and test enamel are fired on one piece and at the same time, thus doing away with any questions which might arise as to possible variations in treatment of separate pieces. This method requires the use of a large number of pieces and is only used in cases where an enamel has shown promise of being a practical one.

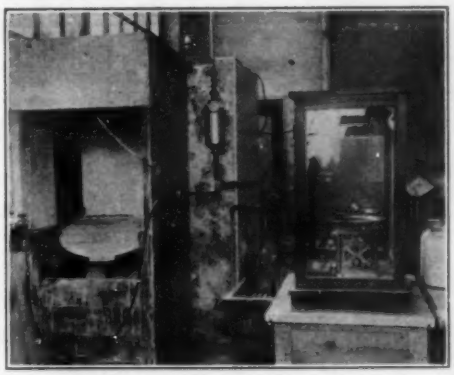

FIG. 1.—Arrangement of spray booth, torsion balance, and sink. There are two spray booths, one backing against the other.

In this method we work from a low temperature to a high one for the reason that it is easier to adjust a rising temperature accurately than a lowering one.

Flat pieces, 8 by 12 inches, are preferable, although any size suitable for the furnace available may be used, the important point being that the same size be used in each comparison between an unknown enamel and the standard enamel.

Enameling of Test Pieces Each piece is lined at the upper surface so as to have equal areas on each side running lengthwise of the piece. One-eighth inch is lined off on each side of the center line so as to leave a $^1/_4$-inch space in the center running lengthwise. This space is left in the ground coat and forms a dividing margin between the two enamels.

In the actual enameling operations the water content of the slip must be known. Knowing the water content of the slip, it is possible, by using an open-pan torsion or other convenient balance or scale, to deposit weighed wet enamel coatings to yield definite dry weight equivalents. Considerable preliminary practice is required and occasionally it is necessary to wash off a coat and start again but with the method it is possible to know before firing the weight of white enamel on the shape.

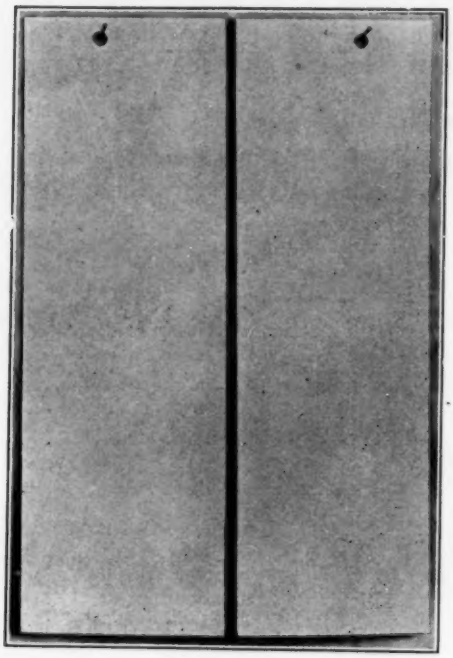

FIG. 2.—Photograph of a 12- x 8-inch panel referred to as a "split panel." This shows method No. 2 of comparing two enamels on a single piece.

The left side is sprayed in the standard enamel at the rate of 0.17 gram dry enamel per square inch, the other half being, of course, shielded during the spraying operation. The pieces are dried, and after brushing to the margin line at the center, each piece is given a final weighing. The 12- by 8-inch pieces are kept within 0.1 gram per coat which is 8 grams per section in the case of the 12- by 8-inch pieces.

The other half of each surface is now coated with the test enamel, carefully shielding the deposit of standard dry film. When dry, the center space is wiped clear and weighed.

Firing A 19- by 12- by 8-inch electrically heated muffle is used for this size. At the back of the furnace a nichrome rod is placed in such a position that an image of the rod will appear when the enamel at the left matures to a luster.

The number of pieces to be used and the number and frequency of temperature gradients will depend upon the case under investigation, but for the purpose of this description it is assumed that the information desired is relative to the action of the enamel at temperatures from 1200 to 1800°F.

The furnace temperature is adjusted to 1200°F. One test piece is placed on the rack in the furnace, which holds the piece in the center of the furnace with enamel strips running parallel to the side walls and low enough off the floor so as to permit the surface to be observed.

The standard only is observed, and by a stop-clock, the time of placing the cold piece in the furnace is noted, as well as the time when the enamel has come to luster as indicated by the image of the rod appearing on the standard enamel surface. The pieces are allowed at each temperature 15 seconds over the time of appearance of the image and removed. It is to be noted that in this as in all firings the standard enamel only is watched during firing, no attention being given to the test enamel while the piece is in the furnace. If the standard enamel does not come to luster at 1200°F in five minutes the piece should be removed.

The furnace temperature is adjusted to 1300°F and another piece is fired following same procedure.

This operation is repeated at 1400, 1500, 1600, and 1700 to 1800°F.

Examination An examination of the enameled specimen along with the time and temperature records will yield definite information as to the firing range and behavior of the test enamel as compared with the standard enamel.

It may be advisable to extend the test to determine the range at more frequent temperature intervals and this can be done by following the same practice.

The extent of tests will of course depend upon individual cases and can be extended to include studies relative to action of the test enamel as compared with the standard under any special condition liable to be encountered in practice.

The group of enameled pieces forms a permanent record of the behavior of the enamel as well as of properties such as luster, opacity, color, and surface.

Conclusion

Using these firing range methods it has been found that enamels vary greatly in behavior under heat. Two enamels may mature to equal luster in exactly the same time at 1600°F, but one of these may fail to mature at a temperature of 1400°F and the other may mature at as low as 1200 to 1300°F.

One enamel may stand a long range of firing temperature and time without showing deterioration, whereas another might show tendency toward loss of opacity, pinholing, etc., at the higher temperatures.

Both methods, particularly No. 2, are time-consuming and require considerable in way of manipulative skill and close attention to detail but the results which have been obtained by the use of these methods amply repay for the time taken.

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ALUMINIUM FLUORIDE IN CAST-IRON ENAMELS[1]

By Alan L. Gormly

ABSTRACT

Aluminium fluoride was used in cast-iron enamels, replacing cryolite. The fluxes were increased, when substituting aluminium fluoride for cryolite, to care for the extra alumina introduced by the fluoride. The costs of an enamel containing cryolite and one containing aluminium fluoride are compared.

Introduction

Aluminium fluoride is a material which has been used but little, if at all, in the ceramic industries. The object of this investigation was to find whether or not cryolite could be replaced by aluminium fluoride in cast-iron enamels.

Procedure

Batches of about 1000 grams of the four enamels in Table I were made up and fritted in a laboratory furnace.[2]

TABLE I

	1*	2*	3†	4†
Feldspar	340.0	380.0	33.0	36.0
Clay	55.0			
Sodium nitrate	5.5	25.0		
Soda ash	21.0	50.0	6.0	6.0
Saltpeter			1.0	2.5
Borax	555.0	165.0	22.5	16.0
Cryolite	110.0		10.0	12.0
Fluorspar	5.5	120.0	1.5	
Magnesium carbonate	5.5		1.5	1.0
Barium carbonate		75.0	12.0	
Zinc oxide		60.0	2.5	2.5
Red lead		175.0		24.0
Tin oxide	188.6	85.0	10.0	
Totals	1286.1	1135.0	100.0	100.0
Coefficient of expansion ($\times 10^{-7}$)	337	324	366	422

* By H. F. Staley, U. S. Bur. Stand., *Tech. Paper*, No. 142.
† For Ceramic Products Cyclopedia, Industrial Publications, Inc., Chicago.

Similar batches containing aluminium fluoride were also fritted. In making these substitutions the amount of fluorine was kept constant; and the refractory portion reduced to balance the additional alumina introduced by the aluminium fluoride.

The frits were ground and applied to cast-iron pieces dry. The enamels were fired in a small laboratory enamel furnace.

Enamel No. 3 was taken as the starting point of the next series of

[1] Received June 26, 1930.

[2] Paul E. Cox, *Jour. Amer. Ceram. Soc.*, **11**, 649 (1928).

enamels. Four batches containing aluminium fluoride were made up, in which the fluxes were increased in varying amounts, and other changes were made to stop the crazing.

The formula of the best enamel of this series is given below.

Feldspar	267	Magnesium carbonate	11
Saltpeter	29	Barium carbonate	91
Red lead	189	Aluminium fluoride	68
Borax	250	Tin oxide	76
Zinc oxide	19		
		Total	1000

Coefficient of expansion = 334×10^{-7}

The empiric formula is

K_2O	0.212			SiO_2	0.977
Na_2O	0.223	Al_2O_3	0.301	SnO_2	0.173
PbO	0.283	B_2O_3	0.445	F_2	0.414
BaO	0.157				
MgO	0.047				
ZnO	0.079				

Results

None of the enamels obtained from the first group had sufficient gloss. Most of them did not fire down smooth, and several were crazed. In each case, however, the enamels containing cryolite showed the same defects as the corresponding ones containing aluminium fluoride.

In enamel No. 2 the fluorspar was replaced by aluminium fluoride, and the feldspar decreased. A much similar enamel resulted with the aluminium fluoride as with the fluorspar.

In the first series a ground coat was used, but it was later dispensed with, when it was found that the cover coats adhered sufficiently without it.

The enamel chosen as a starting point of the second series did not have sufficient gloss and was badly crazed. The coefficient of expansion was reduced by making some changes in the formula. The flux content was increased to increase the gloss. The best enamel was comparable to those produced industrially.

This enamel is probably softer than would be used in industrial work. Because of the small furnace used, it was necessary to make the enamels soft.

The following prices for calculating the cost of the best enamel and a similar one with cryolite were taken from the April, 1930, issue of *Ceramic Industry*.

Feldspar	267 at 0.0115	$3.05
Saltpeter	29 at 0.06	1.74
Red lead	189 at 0.095	18.00
Borax	250 at 0.030	7.50
Zinc oxide	19 at 0.065	1.23
Magnesium carbonate	11 at 0.065	0.72
Barium carbonate	91 at 0.03	2.73
Aluminium fluoride	68 at 0.13	8.84
Tin oxide	76 at 0.415	31.54
Total		$75.35

The cost of the original enamel from which the above enamel was developed figured $69.48.

This comparison of costs of the two enamels is hardly fair, since the enamel containing aluminium fluoride contains more of the comparatively expensive fluxes.

Conclusions

The results obtained from these cast-iron enamels show that aluminium fluoride can be substituted for cryolite, if the fluxes are correspondingly increased to care for the additional alumina introduced by the fluoride.

The results from the fluorspar show that aluminium fluoride could be substituted for other fluorides, if proper changes were made in the formula.

Acknowledgment The writer is greatly indebted to the Aluminum Company of America for the aluminium fluoride used, and to Paul E. Cox for help and suggestions.

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CERAMIC ABSTRACTS

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[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

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Abrasives

Expanding grinder offers refinements in finishing. J. W. HINDES AND JAMES G. YOUNG. *Abrasive Ind.*, **11** [9], 28–30 (1930).—One of the most interesting refinements in the finishing of cylindrical bores has been the introduction of the expanding, floating grinder or so-called hone. The type of tool generally used is in the nature of an expanding segmental wheel, the grinding surface being composed of a series of abrasive stones placed longitudinally upon the circumference of a metal body with an adjusting means for expanding the stones to the walls of the cylinder being ground, and holding them under pressure against the wall, the tool itself being rotated and reciprocated simultaneously. A positive backing is given to the stones to prevent their contraction when meeting some resistance such as a high or hard spot in the bore; spring tension tools would ride over the high spots and dig into low or soft spots. The advantage of the expanding grinding method is the ease with which close limits of accuracy are maintained, giving any desired finish at a high production rate and at low cost. In grinding cast iron it is universal practice to use kerosene as a coolant during the grinding operation; it also serves as a lubricant causing the ready displacement of all broken-down abrasive particles on the face of the stone. In this type of grinding, the use of water has been entirely unsatisfactory because it causes the broken-down particles of abrasive and metal to adhere to the face of the stone, forming a gummy mass. Oil has not been found a satisfactory lubricant and coolant in itself, although recent tests indicate that a small percentage of spindle oil in the kerosene does not interfere with its action. By the use of the finer abrasive stones, 600 grit or finer, a mirror finish can be obtained, no scratches at all being visible to the naked eye. E.P.R.

Hydraulic feed for surface grinder. ANON. *Abrasive Ind.*, **11** [9], 39 (1930).—Gallmeyer & Livingston Co., Grand Rapids, Mich., has introduced a No. 2 size in its line of surface grinders with hydraulic feed for longitudinal movement of table- and cross-feed. The new size is provided with a table working surface of 6 by 18 in. Movement of the control lever on the front of the base at the upper right hand corner will give a wide variation of longitudinal speeds up to 60 ft. per minute. E.P.R.

Electric buffer and grinder. ANON. *Brass World*, **26** [8], 208 (1930).—A line of ball-bearing electric buffers of various sizes is manufactured by the Hobart Bros. Co., Ohio. The machines are adaptable to any regular type of buffing or polishing wheel. The regular line of apparatus is built to operate at 1800 r.p.m., but can be supplied to operate at 3600 r.p.m. for high-speed polishing work. E.P.R.

Bench grinder has general utility. ANON. *Abrasive Ind.*, **11** [9], 38 (1930).—The Hammond Machinery Builders, Inc., Kalamazoo, Mich., has placed on the market a new bench-type electric grinder. This grinder is designed as a general purpose tool and light production grinder. The motor is totally inclosed to eliminate possible injuries from accumulation of dirt and abrasive dust. E.P.R.

High-speed air grinder. H. L. DIXON CO. *Glass Ind.*, **11** [9], 219 (1930).—A new high-speed air grinder, the Kipp, has a spindle speed in excess of 40,000 r.p.m. and is adapted for use with grinding wheels of very small sizes, even wheels of less than an inch in diameter. The wheels may be of various forms to suit the kinds of surfaces to be ground. The device is designed to fit the hand (length, $8^1/_2$ in., weight, 12 oz.). Illustrated. E.J.V.

Vertical coolant pump uses no packing. ANON. *Abrasive Ind.*, **11** [9], 40 (1930).—Tomkins-Johnson Co., Jackson, Mich., has designed a vertical coolant pump, especially adaptable for centerless grinders for coolant purposes. This pump uses no packings and there is no bottom or pan under the impeller to collect grit or chips. E.P.R.

Grind drills for manganese steel. WALTER R. BREELER. *Abrasive Ind.*, **11** [9], 32 (1930).—High-manganese steel generally contains 10 to 15% manganese 1.00 to 1.50% carbon, and the usual small percentages of silicon, phosphorus, and sulphur. Nickel and other alloys sometimes are added to develop special physical properties. Until recently, this wear-resisting steel was considered nonmachineable and parts made therefrom were either cast or forged. New tool steels, new tool designs, and new heat treatments have been perfected; *e.g.*, twist drills made of cobalt high-speed steel, specially designed and heat treated, can cut manganese steel under conditions which would quickly ruin any other drill. In grinding the special drills for manganese steel, the point angle is 68°, the cone angle is 120°, and the lip clearance 6 to 8°. To reduce the rake angle and give a stronger cutting edge, a flat section is ground on the lips. This should also thin the web down to about $^1/_2$ or $^1/_3$ of the diameter of the drill. The drill should not be allowed to idle or rub when starting a cut or after a cut has been started. For best results a hole should be drilled through in one continuous cut. E.P.R.

Chrome-nickel steel polished at mass production rate. E. F. ROSS. *Abrasive Ind.*, **11** [9], 42–46 (1930).—Chrome-nickel corrosion-resisting steel, commonly known as 18–8, is finding many applications for which steel had not been considered a suitable material. The demand for the metal in all its finished forms has thus increased. Designated as Nirosta KA2, an abbreviation for Krupp Austentic No. 2, the alloy contains 17 to 20% chromium, 7 to 10% nickel, carbon under 0.16, manganese under 0.50, silicon over 0.50, and phosphorus and sulphur each with a maximum of 0.025%. The processes and machines used in polishing and preparing chrome nickel steel are discussed in some detail. E.P.R.

Ground bar stock is accurate. ANON. *Abrasive Ind.*, **11** [9], 27 (1930).—Production of accurate round bar stock by the grinding process is an interesting branch of abrasive practice that has been developed within the past few years. The Union Drawn Steel Co. is producing accurate ground stock by the centerless grinding method. The ground stock runs from $^1/_8$ to 8 inches in diameter and in lengths, from 20 to 24 ft. E.P.R.

Use special governor on new air tool. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—Buckeye Portable Tool Co. has introduced a new wire brush and grinder. The tool is governor controlled, with the special feature of air not passing through the governor. It is a heavy-duty tool especially designed for heavy-duty grinding, wire brushing, snagging, and buffing. One of its chief uses is for brushing scale and rust on steel cars and similar surfaces. Illustrated. E.P.R.

Guard controls speed of new grinder. ANON. *Abrasive Ind.*, **11** [9], 40 (1930).—Kling Bros. Engineering Works, Chicago, has a new line of high-speed, heavy-duty grinders. The new grinder is designed for rough grinding and snagging of castings. E.P.R.

Unusual guard. ANON. *Abrasive Ind.*, **11** [9], 40 (1930).—A belt-driven grinding

machine built by Ransome Grinding Machine Co., Oshkosh, Wis., is driven by a belt from an overhead countershaft; the belt is protected to a height of 7 ft. by the guard, which is so constructed that it may be tilted to any angle necessary to accommodate the position of the countershaft and grinder. E.P.R.

Screens and screening practices applied to grading abrasive grains. ANON. *Commercial Stand. Monthly*, **7** [2], 64 (1930).—Tests were run on various samples of grain and a number of sieves measured and inspected through the microscope. As a result of preliminary studies, it was found that the aperture sizes of the openings in the screens (even though within the required limits certified by the Bureau of Standards), have a direct bearing on the amount of grain passing through; *i.e.*, two screens, both meeting the present necessary requirements to be certified as a certain size screen, may vary slightly within the tolerance and still give results which vary from 25 to 50%. The extent of possible variation in screen results is to be studied. E.J.V.

Artificial abrasives. ANON. *Queensland Govt. Mining Jour.*, **31** [7], 293 (1930).—Artifical abrasives are divided into three main groups: (1) metallic abrasives, *e.g.*, crushed steel, steel shot, and steel wool; (2) silicon carbide abrasives, *e.g.*, silicon carbide, cystolon, and carbolon; (3) aluminium oxide abrasives such as alundum, aloxite, exolon, and lionite. Metallic abrasives are used chiefly for sawing or drilling rock; silicon carbide and aluminium oxide abrasives are used in the manufacture of bonded abrasive wheels. A fusible clay is used as the bonding material in vitrified grinding wheels. E.P.R.

Billet sizes regulate grinding costs. L. C. GRIFFIN. *Abrasive Ind.*, **11** [9], 22 (1930).—This article illustrates the paper entitled "Compensating Costs in Grinding Varied Sized Billets" (for abstract see *Ceram. Abs.*, **9** [9], 694 (1930)). A composite example typical of any billet room is outlined. By substituting for the individual production figures given, billet sizes and costs for individual cases may be figured. E.P.R.

BOOKLETS AND CATALOGUES

Grinding machine data. ANON. *Abrasive Ind.*, **11** [9], 46 (1930).—The Cincinnati Milling Machine Co. and Cincinnati Grinders, Inc., have coöperated in publishing a 52-page catalogue covering the standard line of machine tools manufactured by both companies. Illustrations, descriptions, and specifications of knee and column type, automatic and hydromatic millers, and cutter grinders are included. In addition to descriptions and specifications in English, this booklet also contains French and German dimensions and descriptions. The data given are universally complete. E.P.R.

Buffing compositions. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—Lea Mfg. Co., Waterbury, Conn., has issued a pamphlet describing its greaseless buffing compounds. The method of application and typical uses of the series of compounds described are included. Some 50 buffing operations, including stainless steel, carbon steel, plumbing equipment, plated ware, and nonmetallic buffing applications are analyzed and the proper compound made by the company, recommended. E.P.R.

Polishing equipment. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—Lasalco, Inc., St. Louis, has issued a catalogue of materials, machinery, and equipment for polishing and plating. Buffs, abrasives and compositions, glue and glue equipment, and machinery are described. The catalogue is in loose-leaf form and in addition to listing the equipment handled by the company, a section of general engineering data is given. Illustrated. E.P.R.

Polishing data. ANON. *Abrasive Ind.*, **11** [9], 32 (1930).—Hanson-Van Winkle-Munning Co., Matawan, N. J., has issued a complete catalogue of its line of polishing, buffing, and plating supplies. The book, of 128 pp., is divided into 4 sections which describe buffing and polishing wheels, compounds, wire brushes and equipment, plating

equipment and supplies, and polishing machinery. Methods in the manufacture of polishing and buffing wheels are described, and several pages of general plating information and conversion factors are included in the book. Illustrated. E.P.R.

Wheel dressers. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—Desmond-Stephan Mfg. Co., Urbana, Ohio, has issued a catalogue which covers the mechanical abrasive and diamond wheel dressers made by the company. Each type wheel dresser is analyzed as to the type of work to which it is best suited, and illustrations of the tools and their uses are included. E.P.R.

PATENTS

Grinding machine. SIDNEY C. PROBERT AND FREDERICK J. LAMBORN. U. S. 1,772,592, Aug. 12, 1930. A machine for grinding toothed articles having in combination a grinding wheel having a periphery formed to allow the passage of the teeth of a toothed article by a lateral movement of the teeth with relation to the wheel when the wheel is rotated, means for supporting the article in position to be ground with the periphery of the wheel engaged between the teeth of the article, means for rotating the wheel, and means apart from the grinding wheel itself for relatively moving the wheel and article in timed relation to the rotation of the wheel to carry the wheel over the surface to be ground and to carry the teeth past the wheel.

Rail-grinding machine. FREDERICK L. RE QUA AND ARION S. KALENBORN. U. S. 1,772,636, Aug. 12, 1930. A rail grinder comprising a wheeled frame adapted to operate upon a railed track, a motor mounted transversely of the frame, the motor having a shaft extending from both ends of the same, a grinding wheel mounted upon each end of the shaft, the distance between the centers of the grinding wheels being substantially different from the gage of the track, and means for bodily shifting the motor transversely of the frame.

Knife sharpener for slicing machines. WILLIAM J. CAMPBELL. U. S. 1,772,704, Aug. 12, 1930. In association with a slicing machine having a rotary knife and means for driving it, a burr-removing member mounted for engagement with one side of the knife, a grinding member mounted for engagement with the opposite side of the knife, yielding means urging the burr-removing member toward the knife, means for moving the grinding member toward the knife, and means controlled by the grinder-moving means for normally restraining the yielding means, but freeing it upon initial movement of the grinder-moving means, whereby the burr-removing member may engage the knife in advance of the grinder member, the structure including unitary-mounting means for the burr-removing and the grinding members, including the lever adapted to be actuated in unison with a movement of the grinding member toward or away from the knife, and an actuating connection between the lever and the burr-removing member.

Knife sharpener for slicing machines. WILLIAM J. CAMPBELL. U. S. 1,772,705, Aug. 12, 1930. In association with a slicing machine having a rotary knife and means for driving it, a burr-removing element opposed to one side of the knife edge, a control member therefor, yielding means tending normally to thrust the burr-removing element toward the knife, locking means adapted normally to hold the burr-removing element against the yielding means, out of contact with the knife, a grinding element opposed to the opposite side of the knife, a control member therefor, yielding means normally holding the grinding element out of contact with the knife, an external control means for thrusting the grinding element against such yielding means, toward the knife, and means for preventing the application of the grinder to the knife when the burr remover is out of contact with the knife, comprising a projection on the grinder control pin, an opposed locking member on the burr-remover control member, the locking member being adapted to permit the passage of the projection when the burr remover is in operative position.

Grinding machine for finishing borings. KARL JUNG. U. S. 1,772,721, Aug. 12, 1930. An internal grinding machine for grinding borings comprising in combination with the rotatable spindle of the work piece, a grinding tool adapted to be fed in the usual manner in a radial direction and an adjustable grinding tool adapted to be fed in its axial direction and having an outer diameter corresponding exactly to the desired final size of the boring.

Grinding machinery. SOL EINSTEIN. U. S. 1,772,932, Aug. 12, 1930. A machine for precision grinding of the interior surface of a ring tube, etc., including a work rest adapted to engage the outer surface of the article and support the same for free rotation upon the surface and an opposed regulating wheel having its operative surface moving in the direction of the work rest, the regulating wheel being disposed to engage the outer surface of the work piece and control the rotative movement of the work on the work rest, a grinding member disposed intermediate the wheel and rest for internal engagement with the work piece and means for relatively shifting the regulating wheel and the grinding member to bring the grinding member and the work into operative engagement.

Knife grinder. HARRY WITZLEBEN. U. S. 1,773,564, Aug. 19, 1930. A device of the character described, including a rotary grinding wheel, pivoted adjustable blade guides at the sides of the wheel, separate pivoted elements for adjusting the blade guides, unitary wedge means for separately acting on the elements, and a fixed guide along which the unitary means is lengthwise movable, whereby the blade guides are set at precisely equal angles with the wheel to assure an equal bevel on both sides of the blade.

Production of faces of teeth of gear wheels. RICHARD HERRMANN. U. S. 1,773,677, Aug. 19, 1930. A machine for accurately grinding the faces of the teeth of gears, comprising in combination with a bed, a carriage horizontally shiftable on the bed, a grinding spindle in the carriage, a grinding wheel on the spindle, the line-shaped working edge of the grinding wheel having the shape of a cylindrical helical line the pitch of which is equal to the division of the base circle of the gear teeth, means for communicating to the spindle a continuous rotation, means for communicating to the carriage a reciprocating movement in longitudinal direction, means for imparting to the spindle selectively besides the continuous rotating movement an axial displacement and an additional rotating movement or, in stopping the continuous rotating movement, only an axial displacement and an additional rotating movement for the production of the spiral-shaped movement of the grinding wheel, an upright shiftably mounted in the bed, a horizontal work-carrying spindle in the head of the upright, means for adjusting the upright in vertical direction so that the grinding zone of the grinding wheel coincides with the base circle of the work, means for rotating the work of one tooth division, and means for communicating to the work spindle an additional rotating movement for applying the tooth face onto the grinding wheel so that all points of the grinding zone come into contact with all the points of the tooth face.

Grinding implement. THADDEUS A. JACKSON. U. S. 1,773,679, Aug. 19, 1930. A grinding implement embodying a track, a carriage, a grinder, and means for driving it, in combination with means for holding and feeding a drill in a vertical position, the track being inclined longitudinally and having laterally inclined portions at and near the ends thereof for the purpose set forth.

Grinding machinery. GEORGE W. BINNS. U. S. 1,773,937, Aug. 26, 1930. A centerless grinder including a grinding wheel operating at a high grinding rate of speed and an opposed regulating wheel having its operative surface adjacent the grinding wheel moving in a direction opposite to the direction of movement of the grinding wheel surface and at a relatively slow rate of speed to frictionally engage and control

the rate of rotation of a work piece, the wheels forming a progressively narrowing grinding throat therebetween, and a rotatable work-feeding drum disposed adjacent one of the wheels and having work-supporting portions laterally projecting in the direction of the wheels, the parts being so related that the work-supporting portions will extend into the grinding throat for support of a work piece during operation of the machine thereon.

Bringing an unbalanced rotative body into a state of balance. HORACE B. MCCABE. U. S. 1,774,718, Sept. 2, 1930. In a device for measuring the moment of the force of gravity about a horizontal axis intersecting the vertical axis of an unbalanced rotative body, the combination of a pivoted member tiltable in a vertical plane, on which the body may be mounted with its axis intersecting the pivotal axis of the pivoted member, indicating means associatedwith the pivoted member whereby a position of rest with the axis of rotation of the body vertical is indicated, means for establishing a state of equilibrium of the pivoted member in the position of rest and before the body is mounted thereon, and means for measuring the moment of force about the pivotal axis required to restore the state of equilibrium after the body has been mounted on the pivoted member.

Portable grinding and milling machine. LEO SICHEL. U. S. 1,775,000, Sept. 2, 1930. In a device of the class described, a pilot-leveling device adapted for gravity actuation and electrically operative, and a means for setting and automatically readjusting as determined by the pilot-leveling device a grinding wheel or milling cutter to the originally adjusted plane position in a portable machine tool mainly intended for grinding or milling machine tool or other machinery guideways.

Multiple grinding-wheel mounting. AMOS P. STEINER. U. S. 1,775,004, Sept. 2, 1930. A grinding-wheel mounting comprising a spindle, a wheel center mounted on the spindle, the center having fixed flanges and a removable flange to provide for mounting a plurality of grinding wheels, substantially as set forth.

Applying abrasive to polishing wheels. JOSEPH S. PORTER. U. S. 1,775,110, Sept. 9, 1930. An apparatus comprising an endless belt, mechanism for imparting movement to the belt, a hopper with a plurality of compartments for depositing abrasive on the upper surface of the belt, a rotatable wheel-holding clamp adapted to be moved toward and from the upper surface of the belt, and a platform below the belt and beneath the wheel clamp.

Emery-wheel dresser. SAMUEL FRYCKBERG. U. S. 1,775,124, Sept. 9, 1930. A grinding-wheel dresser comprising a guide, a screw to clamp the guide to a support, a dressing tool carried by the guide, and a feed nut threaded on the screw and connected to the tool to move the same in the guide.

Cylinder-grinding tool. FREDERICK G. WACKER AND HERMAN W. ZIMMERMAN. U. S. 1,775,230, Sept. 9, 1930. In a cylinder-grinding tool, the combination of a frame-cage comprising a pair of spaced end plates each having a plurality of radial grooves extending from their center to their outer edges, a plurality of spaced connecting bars rigidly secured to and connecting the end plates, means directly connected to one of the end plates for driving the frame cage, carrier devices rigidly supporting abrasive means and mounted in the frame-cage between the connecting bars, the devices having defined end tongues which snugly and slidingly fit into the end plate grooves to provide the sole guidance and lateral support for the carrier devices, a longitudinally fixed but rotatable threaded support mounted axially within the frame cage, and conical devices threaded upon the support and longitudinally movable with their smaller diameter ends extending in the same direction and toward the driven end plate, means independent of the threaded support for preventing rotation of the conical devices, the carrier devices having surfaces shaped complementally to the conical devices and

engaged by the latter to expand the carrier devices as the threaded support is rotated in one direction and at all times to wedge and hold the carrier devices rigidly in the grooves of the driven end plate.

Forming abrasive articles. E. GARNER AND CARBORUNDUM CO., LTD. Brit. 330,322, July 30, 1930. Abrasive bodies or coatings are formed by spraying a liquid adhesive on the surface to be coated and applying abrasive grain to the surface thus coated. In some cases where it is desired to build up a number of abrasive layers as on paper or cloth disks, metal or wooden rollers, buffing and polishing wheels of cloth, felt, etc., the disk or roller is revolved and a spray of adhesive from one or more jets is directed on one part of the surface which then passes under a hopper from which the abrasive grains are delivered. This is continued until the desired number of layers has been formed. In a modification for fine abrasive grains, the abrasive may be mixed with the adhesive and sprayed on the surface to be coated. Suitable adhesives are natural resins such as shellac in alcoholic solution, synthetic resins in liquid form or dissolved in solvents such as acetone, furfural, alcohol, cresol, rubber latex and rubber solutions, glue or gelatin in water solution, cellulose lacquers, and solutions of sodium silicate. The abrasive coatings are subjected to drying treatment as required by the particular adhesive selected. In order to form abrasive wheels, layers may be deposited on a paper disk or on a metal plate until the desired thickness is obtained, and, after drying, the paper or plate is removed and the wheel trued to exact dimensions in the usual manner.

Grinding edge tools. P. A. AUBIN. Brit. 330,352, July 30, 1930. A device for supporting a tool in front of a grinding wheel is described.

Grinding or abrading machines. J. BATH. Brit. 330,984, Aug. 13, 1930. A grinding or abrading machine comprises a table carrying a rotary work piece and movable axially with respect to the grinding wheel, the latter being carried on a table which is movable both axially and transversely, and the wheel and work tables being carried on a common base, having adjacent parallel guideways.

Grinding and polishing. W. W. TRIGGS. Brit. 331,048, Aug. 13, 1930. Rings, etc., are supported for internal grinding without the use of a chuck by means of a regulating wheel and two steadying rollers, one or both of which may be driven. The regulating wheel, cast iron or abrasive material, is carried by a spindle mounted in ball bearings in a sleeve secured in a split head adjustable in a guide on the base plate by means of four slots to receive clamping bolts. The regulating wheel is mounted on its spindle in part by the sleeve that clamps one of the ball races and in part by a sleeve secured on the end of the spindle.

Grinding ball races, etc. J. D. SCAIFE. Brit. 331,181, Aug. 20, 1930. A machine for grinding raceways for ball bearings, etc., consists of a work head adjustably mounted on cross-slides on a platform and carrying a rotating work-holding plate, the platform being mounted on a vertical shaft, which is oscillated. On the machine bed is mounted a slide movable to and from the work by rack gearing and movable transversely thereof is a slide which is moved to feed the grinding wheel.

Grinding safety-razor blades. W. HEINTSCHEL-HEINEGG. Brit. 331,475, Aug. 27, 1930. Razor blades are ground by wheels mounted in a casing on helical rods whereby the wheels are rotated as they are axially reciprocated by the casing. The blade is mounted on a flexible strip and is twisted so as to lie tangential to both wheels by wings carried by the casing. When the wheels have moved past the blade, the latter springs back to its normal position and is twisted in the opposite direction on the reverse stroke, both sides thus being equally treated. A blade spring passing through apertures in the blade and corresponding apertures in the strip may hold the blade.

Truing gear-grinding wheels. D. BROWN & SONS (HUDDERSFIELD), LTD., AND F. E.

BROWN. Brit. 331,615, Aug. 27, 1930. In a device for truing the grinding wheel of a machine for grinding worm-threads, helical gears, etc., having a tooth contour generated by a straight line moving in a helical path relative to the thread axis, a diamond tool is reciprocated in an inclined straight-line path across the face of the wheel and is at the same time given a combined traversing and angular movement to cause its straight-line path to move in the required helical curve corresponding to the lead of the thread which the wheel is designed to grind.

Truing grinding disks. H. LINDNER. Brit. 331,751, Aug. 27, 1930. Ribbed grinding disks for grinding screw threads, etc., are trued by a correspondingly ribbed roller of a cobalt or tungsten alloy, having holes formed in the surface to entrap dust which is discharged subsequently by the rotation of the roller. The holes are formed preferably in the grooves of the roller and are irregularly spaced, holes in adjacent grooves being staggered; the diameter of the holes preferably is slightly less than the pitch of the ribs.

Art and Archaeology

New method of decoration of glazed tile. J. W. THOMPSON. *Trans. Ceram. Soc.* [Eng.], **29** [3], 99–111 (1930).—It is shown that the decoration of glazed tile by crystallization from solutions is a possibility from the laboratory standpoint. The tile must be perfectly flat and must be placed to dry on a level surface. The surface of the tile must be free from dust and oil. It is possible for the blast supplying the aerographing pen to be oily. It is advisable to pass a damp cloth over the glazed surface as the solution will then flow more evenly. The idea of the method was obtained from the effects produced in the running of glaze cobalt blues and high condensation of acids on ware during the firing. Saturated solutions of the soluble salts of the most common oxides in pottery use were made up, *i.e.*, cobalt sulphate, copper sulphate, and iron sulphate (ferrous). The solution was applied to the surface of a glazed tile by means of a brush (the glaze being of the soft lead majolica type). The tile were left on a flat shelf exposed to the atmosphere. Both copper and ferrous sulphate gave acicular crystals, while cobalt gave a dendritic growth. It was found that a saturated solution was not always the best strength of solution to use, as in some cases a weaker solution gave better results. Other salts were made up into saturated solutions and tried. Position in the kiln is important because the heat treatment which suits one color will not suit another. A saturated solution of copper and ferrous sulphates and also uranium nitrate gives crystals which are too small to give any good results when fired. Cobalt sulphate, manganese sulphate, and chloride give good crystals at all strengths, particularly the cobalt. A 50% solution was found to be best. Weaker solutions do not affect the color, but control the amount of crystallization. Zinc sulphate addition to cobalt and copper tones down the color and softens the crystalline outline. It has a marked effect on copper sulphate in that the acicular crystals practically disappear, resulting in an effective mottle. An addition of zinc sulphate to uranium nitrate helps to keep the radiating crystalline form intact when fired and gives a pleasing effect. Results of the experiments show that the action of zinc sulphate is varied. With copper and cobalt it softens and with uranium it intensifies. Magnesium sulphate additions must be of 50% strength. A saturated solution results in a peculiar dry separation. With cobalt, the tendency is to weaken the color and to give a slight purple tinge. Magnesium sulphate with ferrous sulphate results in a complete loss of crystalline structure on the fired effect. Addition of aluminium sulphate changes the crystalline structure but the fired effect is not one of a crystalline nature. See also *Ceram. Abs.*, 9 [4], 253 (1930). R.F.S.

New materials, new methods. RAYMOND MCGRATH. *Arch. Rev.*, pp. 273–380

(May, 1930) [Anniversary number].—M. shows how architectural methods and design are influenced by glass; metals, plating, metallization, etc.; veneer, ply-wood, laminated board; wall-boards and acoustic materials; flooring compositions; artificial stone, marble, scagliola, etc.; paints, lacquers, varnishes; fabrics; artificial patent compositions. (*D.I.*)

Pottery as a profession. MARGARET PRESTON. *Art in Australia*, **3** [32], 16–18 (1930).—The making of art earthenware is described and a plea is made to Australian artists to originate a culture native to the country. Illustrated. H.H.S.

A little history of faience tile. "MACK" MCGINNIS. *Keramic Tile Jour.*, **2** [7], 26–27 (1930). W.C.O.W.

Polychrome statues in cement. ANON. *Illus. London News*, **177**, 5 (1930).—A Jain merchant of Hoshiarpur, Punjab, India, has built for himself a remarkable house decorated externally with polychrome statues in Portland cement and plaster. A life-sized representation of the coronation of the English King and Queen occurs with figures from Hindu mythology and history. Illustrated. H.H.S.

Single pieces and model sketches (ceramics by Curt Schulz). WILHELM MOUFANG. *Keram. Rund.*, **38**, 24–26 (1930).—Photographs of products of this ceramic artist are given. H.I.

Ceramic plastics. A. HENNIG. *Keram. Rund.*, **38**, 2–6 (1930).—A number of photographs of ceramic figurines produced by the members of H.'s class at the state ceramic school at Bunzlau are reproduced. H.I.

Ceramics by Marguerite Friedlaender. WILHELM MOUFANG. *Keram. Rund.*, **38**, 120–22 (1930).—Works produced by this ceramist and by the students in the trade school which she conducts are described and illustrated. H.I.

Les Innovations Céramiques de Camille Tharaud. YVANHOÉ RAMBOSSON. *Mobilier et Décoration*, pp. 168–73 (April, 1930).—Tharaud has worked unceasingly to discover a means of decorating pottery with colored enamel instead of applying the color separately. Covered jars and vases shown at recent exhibits prove her success. (*D.I.*)

Les Grés de Simmen. G. RÉMON. *Mobilier et Décoration*, pp. 86–92 (Feb., 1930).—The pottery of Henry Simmen, whose crackle ware brings him fame, is described. Bowls, jars, and vases, made by a process of high firing, are simple and beautiful. (*D.I.*)

Color in the tile industry. LEON V. SOLON. *Keramic Tile Jour.*, **2** [6], 35–37 (1930).—An address at the New Orleans convention of the Tile and Mantel Contractors' Assn. of America is given. W.C.O.W.

Exhibit of glass containers. E. W. FUERST. *Modern Packaging*, pp. 29–30 (July, 1930); *Bull. Amer. Ceram. Soc.*, **9** [8], 254–56 (1930). (*D.I.*)

Art and trade show. ANON. *Pottery Glass & Brass Salesman*, **42** [2], 7 (1930).—The second semi-annual Art & Trade show was held in New York, August, 1930. A wide variety of merchandise including various china and pottery products was on display. E.P.R.

Art through the microscope. ALBERT MANN. *Discovery*, **11**, 204–206 (1930).—An exhibition was recently held in Washington, under M.'s direction, to reveal to artists the perfect symmetry and beauty of design of diatoms. Illustrated. H.H.S.

L'Art Décoratif à L'Exposition Internationale de Barcelone. SIMON LISSIM. *Mobilier et Décoration*, pp. 165–67 (April, 1930).—S. gives an illustrated review of decorative art exhibited by different countries at Barcelona. Interiors and objects of art are described. (*D.I.*)

François Décorchemont et la Fâte de Verre. RENÉ CHAVANCE. *Mobilier et Décoration*, pp. 112–20 (March, 1930).—The process of making the comparatively

new "pâte de verre" ware is described. Pâte de verre is harder than glass. It is opaque with beautiful colorings, some resembling onyx. M. Décorchemont has experimented with the composition and firing of this material and thoroughly mastered its technique. (*D.I.*)

La Décoration Française Contemporaine. RENÉ CHAVANCE. *Mobilier et Décoration*, pp. 45–85 (Feb., 1930).—The decorative art of France today is illustrated by the work of many designers. Furniture, china and glass, statuettes, etc., are shown. (*D.I.*)

Triumph of British decorative art. ANON. *Creative Art*, pp. 7–17 (July, 1930).—This article is chiefly a series of full-page photographs showing a day in the life of an Englishman as it was interpreted by British designers and craftsmen at the Monza Exhibition of Industrial and Decorative Art. (*D.I.*)

Homes of color. ANON. *Architect*, **14** [4], 351 (1930).—Brick in almost any hue, from lighter tones of gray, cream, buff, golden, and bronze tints, to mellow greens, blues, reds, and darker shades of maroon, brown, purple, and even gun-metal black can be obtained. The development of various textures has proceeded with changes in color. G.R.S.

The Wesley teapot. ANNA ONSTOTT. *Pottery Gaz.*, **55** [639], 1451–52 (1930).—The Wesley teapot was made by Josiah Wedgwood as a reminder of his meeting with John Wesley in 1761. He put a wreath of garden flowers round the blessing which Wesley used at the Kinswood School, and also the national flowers, the rose for England, the thistle for Scotland, shamrock for Ireland, and the leek for Wales. O. introduced replicas of this famous teapot into the U. S. Illustrated. E.J.V.

Fine old English glasses. IV. Cut drinking glasses. FRANCIS BUCKLEY. *Glass*, **7** [7], 274–76 (1930); for Part III see *Ceram. Abs.*, **9** [10], 813 (1930). H.W.A.

Ojimi. LADY INGRAM. *Connoisseur*, **85**, 365–69 (1930).—Ojimi are beads used on Japanese inro (medicine cases), holding the cords together, while at the other end hangs the netsuke, or toggle. The finest are of gold, silver, or copper, but cloisonné, pottery, and porcelain are used. Illustrated. See also *Ceram. Abs.*, **8** [11], 792 (1929). H.H.S.

New creations in china and glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [5], 15 (1930).—The American Chinaware Corp. has a dinnerware shape known as the "Primrose"; the body is of semiporcelain, flower-like in contour, and is produced in an old ivory body with brilliant crystal, noncrazing glaze. The Fred C. Reimer Co. offers a new decoration on the Fürstenberg china, including an elaborate decorative treatment of gold on a red band. The Dunbar Glass Corp. has a square shape in flatware, unique in glass production. New etching is in the form of a floral bowl. Geo. B. Borgfeldt & Co. is displaying a 32-piece colored glass luncheon set. E.P.R.

China and glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [3], 11 (1930).—Wm. S. Pitcairn Corp. is displaying a new shape of flat ware which is 12-sided. The hollow-ware shows deep wide flanges or edges permitting a fine decorative treatment. The earthenware reproductions of old English types carry an ivory-on-ivory. A. H. Heisey & Co. has a new line of stemware which carries a semisquare base of fanciful description. Geo. A. Hines, Inc., has lamps and shades which have Chinese bases and are topped with shades in Chinese design. Examples of "Pisa" pottery are also displayed. E.P.R.

New lines of domestic and foreign manufacture in glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [2], 11 (1930).—W. S. George Pottery Co. is displaying square shapes in dinnerware to which the Argosy shape has been adapted, modeled along a classic line of Neo-Corinthian cast, and characterized by little ridges applied to the edge of the flatware; a yellow tone and ivory are obtainable. Percy N. Leyland,

Inc. is showing a variety of plates, both in color and gold work. The flat gold is in a lacy pattern set off by a festoon of raised gold done on the old Sheffield plate. Included in the earthenware line is the "Blue Abbey" decoration, first manufactured in 1790. The center decorations show the ruins of an old abbey. The Taiyo Trading Co. is showing Japanese fancy china. Breakfast sets and novelties in blue luster adorned with cubist decoration in two tones or darker blue are shown. E.P.R.

New color scheme in glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [2], 9 (1930).—The Halle Bros. Co. is displaying new color schemes in glassware including amethyst, crystal, cobalt blue and crystal, and black and crystal. The shapes of the stemware are also new. E.P.R.

Up-to-date china and earthenware. ANON. *Pottery Glass & Brass Salesman*, **42** [4], 11 (1930).—Josiah Wedgwood & Sons, Ltd., has a new line of china place plates: (1) Chinese type done with a black band and red medallions, (2) monogrammed plates, the decoration consisting of a monogram set at the left, in raised paste gold set off by a border in black, crimson, or green, and (3) a Queensware, old English bramble design in rich red and brown. The McKenna Bros. Sales Corp. is displaying cut and decorated glassware, notable among which is a square set of decorated glassware obtainable in either black on silver or yellow gold on colored glass. Geo. C. Kindt & Co. is showing shadow and radio lamps. E.P.R.

Porcelain kitchenware from Japan. ANON. *Pottery Glass & Brass Salesman*, **42** [2], 9 (1930).—J. L. Hudson & Co. has a brightly colored porcelain kitchenware display from Japan, including fluted earthenware sets in deep cream, soft green, or deep rose, and Stiegel glass tumblers. E.P.R.

Mosaic rhombic ceramic designs. ANON. *Keramic Tile Jour.*, **2** [8], 26 (1930).—A mosaic tile based on the geometric figure called the rhomboid, is announced by the Mosaic Tile Co. Illustrated. W.C.O.W.

Beauty as a business builder. JULIUS KLEIN. *Merchants' Record and Show Window*, pp. 7–9 (June, 1930). (*D.I.*)

English heraldic glass in America. F. S. EDEN. *Connoisseur*, **85**, 363–64 (1930).—The finest collection in the world of English heraldic glass is to be found at Ronaele Manor, Philadelphia, the residence of Fitz Eugene Dixon. Colored plate illustrations. H.H.S.

Prince Charles Edward Stuart relics. ALISTAIR TAYLER. *Illus. London News*, **176**, 1099 (1930).—Armorial china, etc., pertaining to the Young Chevalier and to the Gordon family of Letterfourie, Banffshire are described. H.H.S.

Dark Ages Exhibition. FRANK DAVIS. *Illus. London News*, **176**, 1050 (1930).—An exhibition of art in the Dark Ages in Europe has been staged in London by the Burlington Fine Arts Club. Illustrated is an amber glass beaker of the 6th or 7th Century, unearthed from a Kentish gravel pit. H.H.S.

Early American glassmaking traced in Toledo Museum tour. ANON. *Amer. Glass Rev.*, **49** [46], 21 (1930).—The earliest period of American glassmaking is traced in the new 15-minute tour of the Toledo Museum of Art galleries, which groups the products of 10 early makers, whose glass is now rare. The examples on display in Gallery XVI represent the works of the early American glass manufacturing establishments. E.P.R.

San Nicolas: A treasure island of the Pacific. BRUCE BRYAN. *Discovery*, **11**, 240–44 (1930).—The Los Angeles Museum expedition to San Nicolas (Passing Isle) returned with one of the most complete collections of prehistoric Indian remains ever assembled in one trip. Stoneware bowls and other artifact possessions of a man were broken at his burial in order that his spirits might serve him in the next world. H.H.S.

Balkan archaeology. ALEC BROWN. *Illus. London News*, **176**, 1208–1209 (1930).—The Belgrade Museum Expedition under Petkovich has excavated Stobi, once capital of Roman Macedonia. A mosaic pavement of early Byzantine pattern is among the discoveries illustrated. H.H.S.

Archaeological awakening of China. ANON. *Illus. London News*, **176**, 1142–43 (1930).—The first work of the kind to be carried out entirely by Chinese savants is the expedition in Honan province under Li Chi, head of the Chinese National Research Institute of History and Philology. Photographs show pottery 3000 years old. H.H.S.

Art treasures from Erech. JULIUS JORDAN. *Illus. London News*, **176**, 1017–19 (1930).—The German archaeological expedition under J. has proceeded with the excavation of Uruk. Clay figurines, terra cotta statues, etc., are illustrated. H.H.S.

BOOKS AND JOURNAL

Art in Industry. CHARLES R. RICHARDS. Macmillan Co., New York, 1929. $2.50 This is a revised reprint of a report of a survey of art industries and art schools in the U. S. by the Department of the State of New York and the National Society for Vocational Education. (*D.I.*)

Europäisches Kunstgewerbe. M. R. J. BRINKGREVE, *et al.* E. A. Seeman, Leipzig, 1928. About $14.00. Examples of the decorative arts of European countries assembled at the Leipzig Fair, 1927, are given. There are 112 plates showing new ideas in glass, enamel, pewter, silver, jewelry, lace, and porcelain. (*D.I.*)

Franz Greenwood and the Glasses That He Engraved. WILFRED BUCKLEY. 14 pp., 30 plates. Ernest Benn, Ltd., London, 1930. Price 25s. Reviewed in *Times Lit. Supp.*, **29**, 516 (1930).—G. (1680–1761) was an 18th Century Dutch resident of English descent, who decorated English drinking glasses by a process of stipple engraving which he appears to have originated. H.H.S.

Prehistoric Malta: The Tarxien Temples. THEMISTOCLES ZAMMIT. xvi + 127 pp. Oxford Univ. Press, 1930. Price 12s. 6d. Reviewed in *Times Lit. Supp.*, **29**, 507 (1930).—Tarxien provides a ceramic mystery; there is a millennium of progress to be observed in the other arts, but the pottery remains supremely good all through the period, yet there are no analogies in the surrounding world which would indicate a foreign source. H.H.S.

Excavations at Olynthus. I. The Neolithic Settlement. GEORGE E. MYLONAS. xvii + 108 pp. Johns Hopkins Press, Baltimore, 1930. Price $8.00. Reviewed in *Times Lit. Supp.*, **29**, 456 (1930).—The settlement had three stages characterized by the pottery found. A potter's kiln found is the earliest known in Greece. Two colored plates illustrate the painted pottery. H.H.S.

Art and Religion of Fossil Man. G. H. LUQUET. Translated by J. Townsend Russell. xiv + 213 pp. Yale Univ. Press, New Haven, 1930. Price $5.50. Reviewed in *Times Lit. Supp.*, **29**, 547 (1930).—L. refuses to regard statuettes of the female form as symbols belonging to a cult of fertility. A large family is little to the taste of a hunting tribe, which would be more likely to encourage infanticide than to stimulate fecundity by magico-religious means. H.H.S.

La Renaissance de l'Art (French and English). Edited by HENRY LAPAUZE. 11 Rue Royale, Paris, and 250 W. 57th Street, New York. Price 200 F. annual, 20 F. per copy. The most important of French art magazines. H.H.S.

PATENTS

Design for bottle, etc. WALTER D. TEAGUE. U. S. 81,897, Aug. 26, 1930; CHARLES A. TOSI. U. S. 81,898, Aug. 26, 1930.

Design for plate, etc. URASABURO TOMITA. U. S. 81,856, to 81,858 Aug. 19, 1930; HARRY A. DWYER. U. S. 81,921, Sept. 2, 1930; BRIAN MCQUILLAN. U. S. 81,938, Sept. 2, 1930.

Colorimeter. FRANK TWYMAN AND JOHN PERRY. U. S. 1,775,148, Sept. 9, 1930. A colorimeter for analyzing the light from a sample in terms of primary colors, comprising a device quantitatively responsive to light of different colors arranged to receive the light from the sample, an indicating device quantitatively actuated by the light-responsive device, a supporting body for the sample and a standard specimen, tint wedges mounted on the supporting body in locations corresponding to those of the sample and standard specimen, and movable colored light filters adapted to be disposed between the source of light and sample specimen.

Decorating pottery, etc. V. G. H. ALCOCK, W. LINDLEY, AND W. BLOORE. Brit. 330,522, Aug. 7, 1930. A spraying nozzle for slip used in decorating pottery has a cut-off valve with a strip of paper or other suitable material on the end of it.

Enameling glass articles. M. JEANDIDIER. Fr. 633,277, April 25, 1927. Directly after or during molding, the articles are dusted over with an enamel which has a coefficient of expansion differing from that of the glass constituting the articles. The enamel fuses and, on cooling, adheres to the glass to give a crazed effect. (*B.C.A.*)

Cement, Lime, and Plaster

Technique of high-quality cements. HANS KÜHL. *Tonind.-Ztg.*, **54** [65], 1069–70; [66], 1098–99 (1930).—For the preparation of high quality cements, it is necessary to use pure raw materials of high quality containing as little sulphuric acid, alkalis, magnesium, etc., as possible. This is important as there is a tendency to prepare cement from industrial waste products. K. gives cement formulas of Jänecke and Guttmann and Gille and compares them to his own. Jänecke considers that Portland cement consisting of alite and celite is a system of dicalcium silicate, tetracalcium aluminate, dicalcium ferrite, and pure lime. Guttmann and Gille have two formulas, one for clinker rich in alumina and the other for clinker rich in iron oxide; for the first, tricalcium silicate, tricalcium aluminate, and monocalcium ferrite; for the second, dicalcium aluminate and dicalcium ferrite. The composition of Portland cement with a varying content of silicic acid, alumina, and iron oxide can be determined from these formulas if the lime content is "correctly" adjusted. In the Jänecke formula the hydraulic modulus is low, while in the formulas of Guttmann and Gille and of Kühl the hydraulic moduli are close to each other. In practice, thorough grinding and mixing are as important as selection of proper mixing proportions. For raw materials rich in silicic acid the wet process of preparation is better because it is more difficult to vitrify such a paste; the dry process is recommended for pastes which vitrify more easily. High-quality cements should be fired until sharply vitrified, for which revolving and shaft kilns are well adapted. To lower the vitrifying temperature of cement, admixtures of fluxes were tried. Good results are obtained with additions of feldspar, chlor-calcium, and gypsum, but great caution is necessary in using these admixtures. The fineness of cement is also important. Tests showed that excessive fineness affects the solidity of cement. This can be explained by the theory of hardening. The setting and hardening of cement is conditioned by the shrinkage of the jell mass. The formation of this jelly depends on the fineness, as the finer the paste is ground the more easily is the jelly formed. On the other hand, the shrinkage of the jelly is brought about by the absorbing action of the coarse granules in the jelly; therefore the degree of absorption depends on the quantity of coarse granules present. The requirements for obtaining a Portland cement of high quality can be summarized

as follows: (1) determination of lime content of raw paste, (2) determination of hydraulic factors, (3) fine grinding, (4) thorough mixing of raw paste, (5) good sintering, and (6) right degree of fineness. M.V.K.

Effect of zinc oxide on cement mortar. PUJOL AND RENGADE. *Rev. mat. constr. trav. pub.*, No. 239 (1929); *Rock Prod.*, **33** [3], 74–75 (1930).—Irregularities were noted in the actions of test specimens at a cement plant in France. There was no apparent reason for the trouble, but it was finally traced to a change from sheet iron to sheet zinc covers on the laboratory tables. Various kinds of cement were then tested, adding 1%, 0.1%, and 0.01% of ZnO to them. Ordinary Portland cement was found to disintegrate in water in some cases, swell and crack in others, and as little as 0.01% ZnO added caused a decrease in strength. Hardening of iron Portland cement was retarded but behavior to water and strengths were normal. P. concludes that zinc picked up by mixing the mortars on the metal reacts with the lime liberated by the setting mortar, acting as a retarder. R. found that minute additions of ZnO to basic slag or "laitier" cements retarded initial hardening and had no apparent influence on fused or alumina cement. Addition of ZnO to lime retards its set greatly and lowers its strength to some degree. The set of white cement is retarded by ZnO and its strength greatly reduced, as little as 0.01% being effective. The start of set of grappier cement is accelerated, the end retarded, and its strength reduced by adding ZnO. W.W.M.

High early-strength concrete. S. RORDAM. *Rock Prod.*, **33** [18], 45–46 (1930).—R. made a comparative study of an ordinary Portland cement concrete and a quick-hardening cement concrete. He regulated the water-cement ratio of the former to give the same strength as the latter at the 3-day period and found that the ordinary Portland cement concrete was increasingly stronger than the quick-hardening cement concrete at the 7-, 28-, and 90-day periods. He concludes that the better way of obtaining high early-strength concrete is by using standard Portland cement and water-cement ratio control. Data in tables and graphs are presented. W.W.M.

Setting of cement. II. HERMANN GESSNER. *Kolloid-Z.*, **47**, 65–76, 160–75 (1929).—After reviewing previous work and theoretical considerations in terms of colloid phenomena, G. describes his own measurements of certain physical properties during the setting of cement. For the measurement of viscosity, 100 parts of Portland cement were mixed with 30 parts of water giving a material of a pasty consistency. The viscosimeter was of the capillary-tube type in which the cement paste and a reference material (glycerine) were passed through identical capillaries under the same air pressure. The relative amounts of cement paste and glycerine passed through the capillaries in the same time, giving a measure of the viscosity of the cement with reference to that of the glycerine. Conclusions from the viscosity measurements are as follows: (1) 100 parts of cement must be mixed with at least 30 parts of water in order that the viscosity during the first two hours may be followed. (2) Immediately after mixing, cement paste has about the same viscosity as glycerine, while mixtures with less water show a higher viscosity and mixtures with more water, a lower viscosity. (3) From the beginning of the experiment there is a slow increase in viscosity which becomes more rapid after $^1/_2$ to $1^1/_2$ hours. (4) The viscosity measurements indicate the formation of a gel. (5) An increase in viscosity is only observed when a new portion of the cement paste which has suffered no deformation is used for every measurement. (6) If the same sample after standing for some time is repeatedly drawn through the capillary, the viscosity decreases considerably because of the destruction of the gel structure. (7) Comparison measurements with the Vicat needle show that no simple relations obtain between the viscosity as measured with the viscosimeter and the depth to which the needle sinks in the test specimen. Conductivities of cement-water mix-

tures were measured with the Ostwald immersion electrode in the thermostat at 25°C. At first the conductivity increased and reached a maximum during the first hour. The maximum probably corresponded to the time when the interstitial liquid is saturated or supersaturated with $Ca(OH)_2$ and begins to separate out. The volume changes of cement-water mixtures were measured by evacuating a spherical vessel containing the cement and observing the change in the water level on a vertical calibrated capillary tube joined to the sphere. Cement-water mixtures showed a volume decrease, the decrease taking place rapidly during the first five days but gradually slowing down although the decrease continued through the duration of the experiment of 275 days. A hydraulic lime measured showed a much smaller volume decrease while fused alumina cement (ciment fondu) showed a much greater volume decrease than Portland cement. Measurements of the water-vapor tension of cement-water mixtures during setting were made by determining gain or loss in weight over sulphuric acid solutions of known concentrations. Curves of water content against vapor pressure show a decided inflection at a pressure of 10.4 mm. of mercury for a mixture 3 days old, but only a slight inflection at this pressure for older mixtures. It is concluded that in the beginning of the setting reaction a definite hydrate exists in the hydrated shell surrounding the clinker grains while later a general transformation of mechanically-held water to chemically-combined water takes place. For Part I see *Ceram. Abs.*, **8** [3], 174 (1930). H.I.

Mill temperatures and setting time of cement. K. KOYANAGI. *Zement*, **19**, 467–69 (May, 1930); *Pit and Quarry*, **20** [10], 76 (1930).—K. has observed that a Portland cement of normal chemical composition became quick-setting when ground in the mills of the plant, although the same cement gave normal setting time when ground in the laboratory mills. A long-time series of tests of mill temperatures compared with the setting time of the cement were made in Japan where, on account of the warm climate, the clinker has little opportunity to cool in storage, and the temperature of the clinker is 60 to 80°C in winter and 80 to 120°C in summer. When the temperature in the mill runs over 160°C, quick-setting cements are frequently formed, and it was observed that a quantity of the gypsum added has a close relationship to quick-setting. In all varieties of gypsum, a shortage in the gypsum content of the cement always makes the cement rapid-setting; superfluous quantities of double- and semi-hydrate probably shorten the time of set but do not make the cement quick-setting; quick-setting cements always are formed with anhydrite. E.P.R.

Rapid determination of magnesia in Portland cement and raw materials. ARTHUR J. POOL. *Rock Prod.*, **33** [17], 80–81 (1930).—The present method used for determining magnesia in cement and materials requires about 24 hours. P. describes a method which requires about one-fourth this time. The magnesia is determined volumetrically by precipitating with a fixed amount of NaOH, filtering, and titrating the excess NaOH used with HCl. W.W.M.

Investigations on lime-alumina cement. I. S. NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **33** [5], 167–69B (1930); *Tonind.-Ztg.*, **54** [66], 1092 (1930).—N. tried to prepare lime-alumina cements similar to those prepared by R. Grün (*Tonind.-Ztg.*, **48**, 247 (1924)), but as Japan does not produce bauxite of high quality necessary for the preparation of alumina cement, the following raw materials were used: limestone, pozzuolana, substances containing silicic acid, such as diaspore, bauxite, etc. These 3 kinds of raw materials were mixed: 60 to 65% limestone, 20% pozzuolana, loam, and colloidal earth, and 20% of substances rich in alumina. The raw paste was mixed with water and made into balls of 10 mm. diameter which were fused at 1300 to 1380° in an electric kiln, then ground in a porcelain mill. Samples poor in silicic acid showed more resistance than those rich in silicic acid. The resistance to

pressure 1:3 of the samples was investigated by the method of S., and it was found that lime-alumina cements after storing in water for 7 days already begin to lose their solidity, but with combined storage show a considerable increase in solidity. It follows that the essential hydraulic components of this kind of cement are aluminates such as $5CaO \cdot 3Al_2O_3$ or $CaO \cdot Al_2O_3$, whose hydration products are easily soluble in water and therefore lose their solidity when stored in water. See also *Ceram. Abs.*, 6 [3], 118 (1927). M.V.K.

Effect of storage on strength of fine-ground cement. N. NICOLAESCO. *Rev. mat. constr. trav. pub.*, No. 242, pp. 401–402 (1929); *Rock Prod.*, 33 [4], 93 (1930); *Pit and Quarry*, 19 [10], 87 (1930).—N. investigated the relation between the fineness in grinding and the retrogression in strengths of Portland cements. A correlation between the fineness in grinding and the retrogression in the strength of the cement has been found. After having been stored for several months in damp air, the cement showed much more residue on the screens than the fresh cement. The conclusions arrived at in studying this phenomena are as follows: (1) The quality of the cement stored under protection from damp air (in a hermetically-sealed bottle or in a bin protected absolutely from damp air) is not affected after a long period of storage. Likewise its fineness in grinding is not affected. (2) Cement exposed to the action of damp air (in bin or sack) suffers a loss in strength. (3) The fineness of the cement is diminished by the retrogression of the strength. (4) The finer the cement is ground, the greater is the action of moisture and the more considerable is the diminution of the quality of the cement. The test data show, therefore, that the diminution of the fineness and the retrogression of the strengths are much greater in the cement of maximum fineness in grinding than for the cement of normal fineness. The final conclusion is that good storage has a decided influence upon the quality of the cement, especially cement of great fineness, which should always be stored in bins impermeable to damp air and protected from all traces of moisture.

Cement		Residue on screens: 900-mesh	Residue on screens: 4900-mesh	Tensile strength, kg./cm.², after 7 days (6 days in air), 1:3 mortar
(*A*)	Normal fineness, tested in fresh state	0.1	11.0	27.20
(*B*)	Same cement, protected from damp air after 4 months	0.1	11.0	27.00
(*C*)	Same cement, after 4 months in concrete bin exposed to damp air	0.2	19.0	24.60
(*D*)	Very finely-ground cement tested under identical conditions as under cements (*A*), (*B*), and (*C*)		5.0	28.47
(*E*)			5.0	28.65
(*F*)		0.1	11.0	24.0

W.W.M.

Moduli vs. lime satiation for computing Portland cement compounds. HANS KÜHL. *Rock Prod.*, 33 [18], 76–77 (1930); for abstract see *Ceram. Abs.*, 9 [7], 500 (1930). W.W.M.

Action of lime on pozzuolana. G. MALQUORI. *Giorn. chim. ind. applicata*, 12 [6], 312–13 (1930).—M. describes results obtained from the study of the action of lime on pozzuolana. Pozzuolana with lime in excess was left to react in water for more than a year. After equilibrium was reached definite volumes of the saturated solution were taken and as much water added. Curves were made of the exhaustion of the lime, which made possible the determination of the changes in the system and the limits of stability of the various solids in contact with saturated solutions. In an orthogonal diagram the abscissas represented the quantity of lime deducted from the first system

with the successive extractions, and the ordinates, the liter in lime per liter of the solution. A horizontal line was obtained corresponding to 1.27 g. CaO per liter (solubility of lime at air temperature). This first horizontal line indicates the solution of free CaO from the immersed substance. Knowing the quantity of lime and pozzuolana used in every sample, it was possible to determine the quantity of lime fixed in the pozzuolana. The results thus obtained with all types of pozzuolana studied for a great length of time are superior to those obtained with the ordinary method of Vicat (about 60 to 70 g. CaO per hundred g. of pozzuolana). The exhaustion curves present another horizontal line corresponding to 1.08 g. CaO per liter, and this value coincides with the limit of decomposition of tetracalcium aluminate dodecahydrate determined by Lafuma. M. does not comment on other irregularities which are observed in the lower part of the exhaustion curve. Probably in that zone of the diagram, the elimination of the lime of adsorption complicates the phenomenon of separation of eventual definite products. By the same method of experiment, M. also studied the action of calcium sulphate on pozzuolana and lime in excess and verified the rapid formation of the expansive sulpho-aluminates of Candlot. This fact is in opposition to the characteristic resistance of pozzuolana mortars to sea waters. M. gives the different factors which determine the resistance of calcareous mortars immersed in aggressive water: physical causes primarily, the impermeability, and chemical causes due to the reaction between the mortar and the salts dissolved in the water in which the mortar is immersed. Both the physical and chemical causes are closely related and neither can be omitted in the calculation. The following constituents are found in ordinary cements and hydrated cements: $Ca(OH)_2$, $SiO_2 \cdot CaO \cdot 2.5H_2O$, $Al_2O_3 \cdot 4CaO \cdot 12H_2O$, or $Al_2O_3 \cdot 2CaO \cdot 7H_2O$. Reactions which have a favorable influence on the mechanical properties of agglomerates other than external causes and the separation through dissolution of components (elimination of free lime and lime of dehydration) are due to the combinations of foreign salts with the constituents of the cement. Calcium sulphate in water containing selenium combines with aluminates to give the salts of Candlot and it is known that Portland cements with an average content of alumina are decomposed by immersion in water containing sulphates. This decomposition is attributed to the combination of foreign salts with the constituents of cement and the formation of sulpho-aluminates which expand. All experimental work on the decomposition of cements in sulphate water has shown that the greater the excess of lime in comparison with alumina, the greater is the dissociation. This conclusion is confirmed by the properties of extra-aluminous cements, cements with a high alumina content, *i.e.*, early high resistance and rapid hardening. These cements are not decomposed by sea water and sulphate water. This fact has contradicted the former current belief that the poor resistance of cement was due to the presence of alumina. On the basis of this opinion it was maintained that cements should have the following qualities to be resistant to sea water and water containing sulphates: low per cent of lime of hydration and aluminates of lime, as the ferro-Portland and nonaluminous cements. For this reason it was supposed by some that with extra-aluminous cements the sulpho-aluminate is not formed because of insufficient quantity of lime, but recent microscopic research has disclosed its existence. Lafuma explains this in the following manner: Calcium sulphate can react with the two tetracalcium and bicalcium aluminates to form the salt of Candlot. In the case of the tetracalcium which does not dissolve alumina, the sulpho-aluminate is formed from a solid product ($Al_2O_3 \cdot 4CaO \cdot 12H_2O$) and is expansive. (If the hydration of $CaSO_4$ takes place in damp air, a noticeable swelling occurs, while this is not observed if the hydration occurs in water because of the dissolution of the $CaSO_4$ and the successive recrystallization of the hydrate salts.) In the case of the bicalcium aluminate which dissolves alumina, the less soluble sulpho-

aluminate crystallizes from the saturated solution and therefore is not expansive. In conclusion, if the sulpho-aluminates are formed from the salts dissolved in the solution which the mortar absorbs, no apparent changes in volume occur. If, however, they are formed from solid salts without previous dissolution they are developed from the chemical stresses which determine the decomposition of the agglomerate. It follows from this that the action of the sulphate of calcium in the immersed cements takes place only if the cement contains tetra-calcium aluminate which can be verified by an indicator of hydrolysis less than one. The chemical action of sea water is more complex. In fact, it is noted that the same mortars which are decomposed in a few months in sulphate water have resisted sea water for several years. In the solution which mortars absorbed, there are present (besides sodium chloride) sulphates, chlorides of magnesia, which with free lime form sulphates and chlorides of sodium and magnesium by a mutual exchange. It is this sulphate of calcium with the aluminate which gives rise to the sulpho-aluminate; if the latter is formed in the presence of excess lime, it expands and causes destruction of the mortar. Sodium chloride increases the limits of decomposition of aluminates, of the silicates, and of sulpho-aluminate, but does not destroy them; it also has a definite chemical action on the calcium-aluminates. If the solution which the mortar absorbs contains 30 per M of sodium chloride, the tetra-calcium-aluminate is decomposed into bicalcium-aluminate, and if the concentration of sodium chloride is greater (as seems to be the case in the interior of the immersed mortar) the sodium chloride combines with the aluminate and forms a chloro-aluminate of calcium. Calcium sulphate acts as much on chloro-aluminate as on aluminate and forms the salt of Candlot. In the presence of excessive lime the solution of sodium chloride does not permit the existence of the tetracalcium; it does not dissolve, therefore, the bicalcium and the chloro-aluminate. In commercial pozzuolana mortars the acid elements are always in excess of the lime. Here the sulpho-aluminate is formed from the bicalcium-aluminate which is a nonexpansive product. The most important function of colloidal silica for setting and hardening, especially with regard to impermeability, has not yet been satisfactorily determined. M. states that the considerations given here can only be hypothetical due to the lack of experimental data. He indicates further the necessity of studying the velocity of formation of setting and hardening compounds with respect to the possible formation of products which the mortars can form with salts contained in aggressive water. M.V.K.

Lime burning with natural gas. ANON. *Rock Prod.*, **33** [18], 49–52 (1930).—Natural gas as a lime-burning fuel is objected to because of its greater cost as compared with coal and the difficulty of holding down the temperature. Burning finishing hydrate requires a large flame of moderate intensity like that of wood or coal gas, but the Moores Lime Co. of Ohio, makers of quicklime and hydrate which is not for finishing purposes, has used natural gas for nearly 30 years. The saving in labor makes it about equal to coal in cost. The plant and production processes are described, as are the quarry operation and water supply. Illustrated. W.W.M.

Existence of monocalcium aluminate in solution. A. TRAVERS AND SCHNOUTKA. *Compt. rend.*, **189**, 182–83 (1929).—When a solution of an aluminium salt is treated with lime water three distinct phases of the reaction are recognized: (1) hydrated Al_2O_3 precipitates out completely when the ratio of CaO to Al_2O_3 is 3:1; (2) addition of one more molecule of CaO causes complete dissolution of the precipitate; (3) further addition of lime water causes precipitation of crystals whose form varies with the p_H of the solution. The dissolved compound in the second stage is $CaO \cdot Al_2O_3$ or $Ca(AlO_2)_2$ by analogy with the crystallizable alkali aluminates. It is impossible, however, to crystallize this from solution because of the much greater insolubility of polycalcium aluminates which crystallize out in hexagonal plates. It is the reaction

which takes place when high alumina cement is shaken with water, being further promoted by the hydrolysis of the dicalcium silicate present in the cement. R.H.E.

Accounting for ignition loss in analysis of clinker. KATSUZO KOYANAGI. *Rock Prod.*, **33** [17], 81 (1930).—This article is a reply to A. J. Blank (see *Ceram. Abs.*, **9** [9], 708 and **9** [8], 617 (1930)). K. states that decrease in strengths of cements which he tested was not due to underburning or careless storage, as suggested by Blank. W.W.M.

Disintegration of cement clinker made from slag. JEAN MUNDORF. *Rock Prod.*, **33** [18], 76 (1930); for abstract see *Ceram. Abs.*, **9** [8], 615 (1930). W.W.M.

Failure of mortar to harden. OTTO FRIZ. *Tonind.-Ztg.*, **54** [65], 1070–71 (1930).—F. describes different cases where plaster mortar failed to harden; although the surface of the mortars hardened, the interior remained paste like. The composition of such mortars is given. An addition of 12 to 15% of Portland cement to the lime would increase the hardening capacity of the mortars, especially when used for covering surfaces other than fired brick or sand-lime brick. M.V.K.

Concrete and sea water. ANON. *Tonind.-Ztg.*, **54** [57], 949 (1930).—Portland cement is the most affected in that part between the low- and high-water level, because it is alternately dry and wet. An agent for increasing the resistance has not been found. Experiments were made with a wood covering and additions of lime-setting substances. Four kinds of cement in two different mixture proportions were used. Moler cement was most resistant to pressure and tension, containing less lime than alumina cement but a significantly greater silicic acid content. A thin mortar cannot be used in sea water except in the proportion of 1 : 2. M.V.K.

Causes of decomposition of concrete. R. GRÜN. *Der Bauingenieur*, **26**, 451–54 (1930); *Tonind.-Ztg.*, **54** [61], 1021 (1930).—It was found that water poor in lime and water containing carbonic acid are detrimental to concrete sluices. Carbonic acid in water changes lime into a soluble double carbonate of lime which combines again with more lime to form the simple insoluble carbonate of lime; this fills the hollow spaces in concrete and remains under its surface. Expansion does not occur during these processes but with time, concrete may decompose from the withdrawal of lime and the cleavage of silicates. The best remedy is the preparation of a dense concrete which prevents the passage of the destructive water to the interior. M.V.K.

Protection of concrete against aggressive water. HANS VÄTH. *Tonind.-Ztg.*, **54** [61], 1010–11; [62], 1026–28 (1930).—Different kinds of German cements were immersed in ground water containing $CaSO_4$ for different periods of time. Results show that the resistance to pressure of these cements was greatly lowered. M.V.K.

Gypsum and gypsum products manufacture. II. S. G. MCANALLY. *Rock Prod.*, **33** [17], 66–69 (1930).—M. discusses the calcination of gypsum, showing rate of loss of water, temperature curve, and change in density of the material. He gives data on the setting of calcined gypsum. There are two periods of calcination: from gypsum to hemihydrate, at 305°F, and from hemihydrate to soluble anhydrite, at 370°F, also two periods of hydration; from soluble anhydrate to hemihydrate, producing much heat, and from hemihydrate to gypsum, producing a smaller amount of heat. M. states that there are 5 compounds of calcium sulphate: $CaSO_4$, $CaSO_4 \cdot {}^1/_2H_2O$, $CaSO_4 \cdot H_2O$, $CaSO_4 \cdot 1{}^1/_2H_2O$, and $CaSO_4 \cdot 2H_2O$. He describes the effect that raw gypsum would have in stucco and the difference between "single-boil" and "double-boil" plasters. Plaster-setting phenomena are set forth and analogies between the dehydration of gypsum and the hydration of plaster of Paris are discussed. For Part I see *Ceram. Abs.*, **9** [9], 712 (1930). W.W.M.

Manufacture of gypsum plasters. II. A. M. TURNER. *Rock Prod.*, **33** [18], 55–57

(1930).—T. describes the calcination of gypsite and gypsum by interpretation of the thermometer-chart curves, going into detail on the production of first-settle and second-settle stuccos from gypsum. Two methods are given for producing artificial second-settle stucco, since the old method for producing second-settle stucco is becoming antiquated. The raw material should be dried before it is put in the kettle and the end point of calcination should be made less arbitrary. For Part I see *Ceram. Abs.*, 9 [10], 824 (1930). W.W.M.

Effect of gypsum on decomposition of tricalcium silicate by heat. THOMAS F. MULLAS. *Rock Prod.*, **33** [18], 62–63 (1930).—Laboratory experiments showed that gypsum accelerates the decomposition of tricalcium silicate. Using this information M. attempted to determine the amount of tricalcium silicates in several clinkers by mixing them with ground gypsum, igniting at 1000°C, and determining the increase in free lime. Data are given in tables and graphs. W.W.M.

Travertine and its imitation. CLIFFORD W. SPENCER. *Arch. Forum* [Part 2], **53** [2], 247–52 (1930).—Travertine was first used as building material 20 years ago. Since then its demand has increased. The bulk of commercial travertine comes from the Tivoli district of Italy, which is in close proximity to extinct volcanoes. Travertine is, however, formed as a deposit from lime springs. Hot springs are especially productive of this form of calcareous tufa and it is found in varying amounts in all parts of the world. Artificial travertine, because of its relatively low cost, has found wide demand and can be roughly grouped under three major classes: (1) precast imitations which match the genuine stone in all respects and must be carefully prepared; (2) other precast products which only approximate the appearance of the real stone and may be prepared roughly; and (3) that which is directly applied to the wall in the same manner as ordinary plaster. The materials used include gypsum plaster, Keen's cement, and in some cases Portland cement. E.P.R.

Researches on the rotary kiln in cement manufacture. II. Measurement of coal consumption of cement rotary kilns by analysis of exit gases. GEOFFREY MARTIN. *Rock Prod.*, **33** [17], 60–62 (1930).—M. gives three methods, including that of Hans Kühl, for computing from the exit gas analysis the fuel consumption per 100 T. of clinker produced; also examples of theoretical combustion, combustion with excess air, and incomplete combustion with production of CO. For Part I see *Ceram. Abs.*, 9 [10], 826 (1930). W.W.M.

Recovery of waste heat in cement plants. LEBRUN. *Rev. mat. constr. trav. pub.*, No. 242 (1929); *Rock Prod.*, **33** [5], 88 (1930).—In discussing the effect of moisture content of cement slurry upon the heat balance of the cement plant, L. states that in the wet process nearly 30% of the total heat is lost in the waste gases. *E.g.*, in a kiln 3 m. in diameter and 55 m. in length, capable of producing 200 metric T. of clinker in 24 hours, the coal consumption amounts to about 270 kg. per T. of clinker, the coal having a thermal value of 7500 W.E. Under this condition, the temperature of the waste gas at the stack is about 300°C, the equivalent of 85 kg. of coal per T. of clinker thus being lost. At this temperature, the recovery of heat from the waste gases is difficult. In order to be able to generate sufficient steam to supply all the power requirements of the cement plant, the minimum waste-gas temperature should be about 550°C. When using a good waste-heat recovery boiler and with waste gas at this temperature, from 0.700 to 0.800 kg. of steam of 20 kg./sq. cm. pressure and of 350°C temperature could be generated per kg. of clinker. To attain this result, however, the only practical method of feeding cement kilns is that of automatic and continuous charging of raw mix, the moisture content of which has been reduced to 20% in order that the waste-gas temperature at the stack can be raised to 550°C. A Hertenbein continuous rotary filter is used, which receives the slurry at 40 to 43% moisture content

and feeds it at 20 to 23% moisture content directly into the kiln. The drum of this filter consists of independent, juxtaposed sections, each covered with a filtering web. A chain-driven metal cylinder, placed on a parallel axis, revolves around this filter drum at the same peripheral speed; this cleaning roll removes the layers of sludge from the filter sections. The slurry is held to the filter sections automatically by means of a vacuum pump. When the filter section arrives at the set of kiln-feeding rollers, the vacuum pressure is released, and by means of a slight pressure (10 g. per sq. cm.), the filter section swells slightly and the paste is detached. W.W.M.

Comparison of balls and cylpebs as grinding media. K. KOYANAGI. *Rock Prod.*, **33** [17], 58–59 (1930).—K. investigated the use of balls vs. cylpebs (solid cylinders) in the finishing compartment of a compound cement mill. With the same clinker and the same quantity of small balls and cylpebs, the balls ground faster at first but slower toward the end of the mill than did the cylpebs. This was due to the cushioning effect of the fine cement which seemed to flake and stick to the balls more than to the cylpebs. Graphs and data are included in the article. W.W.M.

Firing cement on a traveling grate. ERICH SCHIRM. *Tonind.-Ztg.*, **54** [59], 978–81 (1930).—A description of different types of traveling grates used for firing of cement is given. M.V.K.

Tentative specifications for quicklime. ANON. *Pit and Quarry*, **20** [10], 55–56 (1930).—The Federal Specifications Board is adopting and promulgating specifications for various commercial commodities purchased by the various departments and establishments of the U. S. Government. These specifications, in the formative stage, are submitted to representative manufacturers for their comment and criticism and the board is glad to receive comments or suggestions as to changes which may be thought desirable in the specifications. The following items are selected and condensed from Specification No. 250, which deals with quicklime. Quicklime is of two types: type *C*, calcium; type *M*, magnesium. Quicklime must conform to the following composition calculated to the nonvolatile bases: calcium and magnesium oxides, min. 95%; silicon, aluminium, and iron oxides, max. 5%; carbon dioxide, max.: if sample is taken at the kiln, 3%, and if sample is taken elsewhere, 10%. Quicklime must not contain more than 3%, by weight, of waste. Methods are given for sampling and inspection of bulk lime, chemical analysis, and waste determination. E.P.R.

Experiments on concrete road joints. ANON. *Engineering*, **130** [3370], 210 (1930). A.A.

Cement from California for Boulder Dam projects. ANON. *Pit and Quarry*, **20** [11], 27 (1930).—The Boulder Dam and Colorado River projects afford the opportunity to Calif. cement plants to furnish the major portion of the Portland cement required; about 10,000,000 bbl. will be required. E.P.R.

Use aerial tramways in cement plant in Italy. ANON. *Ind. del Cemento* [Milan], **27**, 6–10 (Jan., 1930); *Pit and Quarry*, **20** [10], 76 (1930).—The new plant of the Fabbrica Cemento Portland Montandon at Merone, Italy has the largest line carrying limestone of such size as to provide an eventual capacity of 70 T. per hour with the buckets moving at a speed of 150 m. per minute. E.P.R.

Meeting of the Concrete Union of Finland. ANON. *Tonind.-Ztg.*, **54** [65], 1077 (1930).—Lennart Forsen made a report on his investigations on the reactions of cement with water. In testing clinker powder (cement without gypsum), a great number of chemical compounds without gypsum or calcium chloride can be used for the regulation of the setting time. These regulators of the setting form chemical combinations with the calcium aluminate in the clinker. Some of these were isolated and investigated. By this means the reaction of the setting, quick-setting, normal setting, and the so-called "false quick-setting," can be investigated and probably explained. M.V.K.

Recent Japanese research in Portland cements. WILLIAM A. ERNST. *Rock Prod.*, **33** [18], 47–48 (1930); see also *Ceram. Abs.*, **9** [10], 824 (1930). W.W.M.

New Spanish cement standards. GOSLICH. *Tonind.-Ztg.*, **54** [62], 1023–24 (1930).—The new standards for Spanish cements are tabulated and compared with German standards. An international standardization of cements is needed. M.V.K.

BOOK

Some Writers on Lime and Cement from Cato to Present Time. CHARLES SPACKMAN. Reviewed in *Engineering*, **130** [3368], 133 (1930); see also *Ceram. Abs.*, **9** [10], 826 (1930). A.A.

PATENTS

Waterproofing cement and composition therefor. FREDERICK W. HUBER. U. S. 1,772,999, Aug. 12, 1930. A process of treating hydraulic cement for water-proofing and for accelerating the development of strength in the set cement, which comprises incorporating with the cement, water in amount sufficient to produce a plastic mass, and an emulsion of an aqueous liquid containing in solution at least one substance selected from the group consisting of calcium chloride, hydrochloric acid, calcium nitrate, nitric acid, ammonium chloride, sodium carbonate, and potassium carbonate in a viscous petroleum oil containing asphaltic constituents, the oil constituting the external phase.

Accelerating and improving hydraulic cement. FREDERICK W. HUBER. U. S. 1,773,001, Aug. 12, 1930. A ground mixture of Portland cement with a small percentage of a colloidal gel-like reaction product of calcium chloride, water, and Portland cement.

Manufacture of alumina cement. BÉLA SPIEGL. U. S. 1,775,575, Sept. 9, 1930. A method of manufacturing alumina cement, comprising grinding a raw mixture of lime and bauxite, the latter having an iron content of 5 to 15%, to a fineness such that at least 3% of the mixture cannot pass through a 900-mesh sieve, and at least 15% cannot pass through a 4900-mesh sieve; and calcining the ground mixture at a temperature at least 100° below the melting point until it shows a chocolate-brown color.

Cementitious materials. G. O. CASE, E. M. ELLIS, AND L. H. MONTIGUE. Brit. 330,278, July 30, 1930. A cementitious material comprises an intimate mixture, in a finely-divided state (cement fineness), of natural calcium or magnesium carbonate rock and its respective oxide, or mixtures of two carbonates and oxides, in such proportions as to give in the mixture a ratio of pure carbonate to oxide of approximately 4 to 1. The cementitious material may be made by mixing the natural rock and lump lime or magnesia and then grinding to cement fineness by grinding the ingredients first and then mixing them, or by partially calcining the natural rock to give the required proportion of oxide and then grinding. Retarding and accelerating agents such as colloids and calcium sulphate may be added. The mixture may be mixed with sand, stone, fibers, etc., to make mortar, plaster, or concrete. Specification 173,015 is referred to.

Portland cement. BRITISH PORTLAND CEMENT MANUFACTURERS, LTD., S. G. S. PANISSET, AND W. S. HANNAH. Brit. 331,584, Aug. 27, 1930. White Portland cement is produced by treating the raw materials with a reducing agent immediately after the calcination process, after which the clinker is rapidly cooled to prevent reoxidation. The reduction may be effected by a spray of a reducing powder, *e.g.*, coal dust or by causing the red hot clinker to fall on a surface covered with a volatile reducing agent, *e.g.*, paraffin oil. Cooling is effected by immersion in a trough of water, from which the clinker is removed by a conveyer while still warm enough to drive off moisture. According to the Provisional Specification the reduction may be effected during calcination,

Cement. ROBERT I. LEVY. Fr. 680,762, Aug. 24, 1929. A fused cement is made with regulated cooling of the cement in fusion coming from the furnace to avoid a rapid hardening and to obtain a size of clinker which does not require crushing before setting. Hot air or gases from the furnace may be blown through the cement. Fr. 680,763 describes the manufacture of an aluminous cement in a rotating furnace from clinkers of screened Portland cement with a crude flour containing Al_2O_3 and $CaCO_3$ and heating the mixture to a temperature below its freezing point. (*C.A.*)

Enamels

Report of Enamel Division Standards Committee, 1930. R. D. COOKE. *Bull. Amer. Ceram. Soc.*, 9 [9], 269–71 (1930).—Three methods, previously tentative, were checked. Two were recommended for adoption as standard, while the other was approved as a revised tentative method. The first two were: (1) method for fineness of wet-milled enamel, with a note added; (2) standard method for deformation temperature of enamel; and (3) method for resistance of sheet-steel enamel to deflection. These methods are discussed in detail. Illustrated. E.J.V.

Pickling principles in galvanizing. II. WALLACE G. IMHOFF. *Iron Age*, 126 [2], 82–83 (1930).—Pickling time is not a controlling factor in this work. It is directly related to the following controlling factors: acid strength, temperature, thickness and kind of scale, contamination of bath with iron salts, and agitation. For Part I see *Ceram. Abs.*, 9 [3], 165 (1930). E.C.C.

Mill tops. ANON. *Amer. Enameler*, 3 [6], 6 (1930).—Variation in color between two mills of enamel of identical formula is usually caused by carelessness in scraping in the mill. Great care must be taken not to lose part of the oxide addition during scraping in. When washing the top after scraping it, hold it over the mill and wash it with a sponge (rather than to wash it in the sink where the heavy deposit of oxide on the top will be lost). J.N.U., Jr.

New enamel applied dry on cast iron and plates. ANON. *Emaillewaren-Ind.*, 7 [30], 234–35 (1930).—In the newest enamels, metallic bases such as zinc oxide are frequently used instead of lead, but in such small quantities that fusion takes place only with a considerable increase in temperature which often completely deforms the objects to be enameled. This disadvantage can be removed by adding at least 25% of a dibasic metallic oxide, the zinc oxide. Such an enamel paste is finely ground and sprinkled on the objects. Colored enamels are obtained by adding the coloring coating to the object as soon as the first, the white coating, begins to melt. For the preparation of enamels containing fluorine and boron with zinc oxide as base, sand, quartz, and silica are used for the silicic acid content; for boric acid, sodium biborate and crystallized boric acid are used; calcium fluoride or fluorspar, cryolite, and alkali salts of fluosilicic acid supply the fluorine; zinc oxide or zinc carbonate are used as two-valenced metallic bases; for lime: chalk, marble, limestone, or boron sodium calcite; and as alkalis: sodium or potassium nitrates or carbonates. The pure white, opaque enamel used as a first coating for decorative enamels has the following composition: silicic acid 22.63%, alumina 3.76%, lime 3.5%, zinc oxide 30%, caustic soda 9%, caustic potash 2.6%, antimony oxide 12.5%, boric acid 13%, and fluorine 1.22%. The decorative colored enamel consists of 2 to 20% silicic acid, 30 to 35% zinc oxide, 35 to 70% crystalline borax, 2 to 20% alkali nitrate, 0 to 8% alkali fluoride, and 0 to 30% lime combined with carbonic acid; as coloring ingredients: iron oxide, cobalt oxide, manganese oxide, etc. By means of additions of zinc oxide, antimony oxide, or an increase in the zinc content, this mass can be made completely opaque. M.V.K.

Control of quality and combustion in making steel. ANON. *Iron Age*, **125** [23], 1669–72 (1930).—Combustion and chemical control are discussed. E.C.C.

Testing cast iron. ANON. *Iron Age*, **125** [23], 1679–80 (1930). E.C.C.

Dry scrapings. ANON. *Amer. Enameler*, **3** [7], 7 (1930).—Scrapings never give as good results as fresh enamel. Though the reason is not known, it has been definitely determined in a series of experiments that if the scrapings are kept moist (by keeping the spray booth wet) better results will be obtained than if the scrapings are allowed to dry out before being remilled. This procedure also removes dust from the booth, lessening the chance of getting the wet enamel specked by flying material. J.N.U., Jr.

Metal cleaning. E. G. PORST. *Amer. Enameler*, **3** [6], 9; [7], 5 (1930).—No one of the many cleaning solutions on the market can do all kinds of work. The type of cleaner to be used for each job is determined by the kind of dirt to be removed. The process of metal cleaning can be divided into two steps: (1) wetting the dirt, and (2) suspending the dirt. Emulsification, or lowering of the interfacial tension is an important part of the wetting process, and depends largely on the scrap compounds in the cleaner. After the wetting process, the actual dislodging of the dirt is accomplished in one or more of the following ways: (1) saponification, (2) dissolving, (3) dissolving chemically, (4) agitation, (5) colloidal action, and (6) heating. A brief description of each process is given. J.N.U., Jr.

White opacifiers with zirconium base for enamels and glazes. ANON. *Emaillewaren-Ind.*, **7** [31], 44–45 (1930).—Among the opacifiers which have zirconium oxide as a base, the product, Terrar, has special advantages for the manufacture of enamels and glazes. Like tin oxide opacifiers, it is not poisonous and has chemical stability; on the other hand, the variety in kind and quality of Terrar makes it suitable for different purposes, which is not the case with tin oxide. There are special kinds suitable for different processes of enameling and glazing and for different firing temperatures. Special Terrars for ceramic glazes are distinguished by the superior quality of the coat and the resistance. Terrar is not affected by lead and can therefore be used in lead glazes. It comes in pure white or different nuances of white, as desired. M.V.K.

Zinc oxide in enamels. VIELHABER. *Emaillewaren-Ind.*, **7** [33], 257–58 (1930).—Zinc oxide is introduced in powder enamels for obtaining an easily fusing, lustrous enamel which contains also 10 to 12% boric acid and an increased alkali content. Zinc oxide acts well as flux and is indispensable in powder enamels because it does not diminish the turbidity power of other oxides, *e.g.*, the tin and antimony oxides, as is the case with boric acid and alkalis. The compositions of enamels containing zinc oxide are given. M.V.K.

Antimony oxide. ANON. *Emaillewaren-Ind.*, **7** [29], 226–27 (1930).—Antimony oxide is an exceptional turbidity agent but its use in enamel industry is limited because of the property of the three-valenced antimony oxide to form poisonous compounds, which prohibits its use in objects for eating, cooking, or drinking. Besides these disadvantages, antimony oxide cannot be added or mixed in the mill as zinc oxide and other substances. The five-valenced antimony oxide with sodium (leuconine) is nonpoisonous and the preparations of antimony oxide in its five-valenced form (leuconine, candorine, pentamone) are used in industry. M.V.K.

Coefficient of expansion. VIELHABER. *Emaillewaren-Ind.*, **7** [31], 243–44 (1930).—The great importance of the expansion coefficients of enamels is discussed. Experiments of recent years have established the fact that crazing occurs when the expansion of the enamel is greater than that of the cast iron, and further, that enamel warps and breaks off if the expansion coefficient is too small. M.V.K.

Drying installations of a modern enamel factory. WILHELM LINKE. *Emaillewaren-*

Ind., **7** [29], 227–29 (1930).—L. discusses the place of drying installations in enamel factories and the necessity of utilizing waste heat for drying ware. M.V.K.

Vitreous enameling of stove parts. E. F. BERRY. *Metal Cleaning and Finishing*, **2**, 341–44 (1930).—Complete discussion of application of various enamel coatings to stove parts including pickling, sandblasting, and enameling procedure as employed at the plant of Mansfield Vitreous Enameling Co., Mansfield, Ohio. Electric enameling furnaces are described. (*C.A.*)

Tunnel furnace for enameling. C. B. PHILLIPS. *Iron Age*, **126** [3], 159–61 (1930).—The new tunnel furnace of the American Stove Co. is described. A central wall through the tunnel enables two-coat work to be done on a counter-flow principle. A special type conveyer is used which cuts cost to a minimum and conserves floor space. E.C.C.

Use of a continuous furnace. ANON. *Ceram. Ind.*, **15** [3], 276–86 (1930).—An illustrated description of the plant and processes of the Cribben & Sexton Co., stove manufacturers of Chicago, is presented, with operating costs before and after changing from batch-type furnace and drier to continuous furnace and drier. W.W.M.

Foundry practice for enamelers. S. H. HOBSON. *Ceram. Ind.*, **15** [3], 287 (1930).—H. answers a questionnaire on foundry practice in the production of castings to be enameled. W.W.M.

Enameling plant troubles. H. C. GOUDY. *Amer. Enameler*, **3** [6], 3–4 (1930). J.N.U., JR.

Enamel, from jewelry to everyday use. S. PROCTOR RODGERS. *Amer. Enameler*, **3** [6], 5–6; [7], 9–10 (1930); reprinted from *Industrial Gas* of December, 1929.—A sketch is given of the use of enamels first on jewelry, then on commercial ware, from the time of the Egyptians up to the present. It is stated that the present trend is for enameling plants to buy their enamel frits from a regular supplier rather than to make them themselves. A description is given of the making of frit in the plant of the Porcelain Enamel & Mfg. Co. of Baltimore. J.N.U., Jr.

PATENT

Enameling. DEUTSCHE GASGLÜHLICHT-AUER-G.M.B.H. Ger. 500,258, Sept. 27, 1927. A dull enamel layer is prepared by firing onto a normal enamel layer a mixture of enamel with the difficultly fusible aluminous constituents of the enamel, the proportion of enamel in the second layer being only about 10%. (*C.A.*)

Glass

Devitrification of soda-lime-silica glasses. GEORGE W. MOREY. *Jour. Amer. Ceram. Soc.*, **13** [10], 683–713 (1930).—The isotherms and boundary curves in that portion of the ternary system $Na_2O{\cdot}SiO_2$–$CaO{\cdot}SiO_2$–SiO_2 of direct application to glass technology, *viz.*, from 64 to 78% SiO_2, 0 to 20% CaO, including the whole of the field of the compound $Na_2O{\cdot}3CaO{\cdot}6SiO_2$, and portions of the adjoining fields of $Na_2O{\cdot}2SiO_2$, $Na_2O{\cdot}2CaO{\cdot}3SiO_2$, $CaO{\cdot}SiO_2$, tridymite, and quartz have been determined with greater precision than in a previous study by greatly increasing the number of mixtures studied, and thereby decreasing the interpolation necessary in the interpretation. An extended discussion is given of the devitrification of glass, in which it is shown that the liquidus temperature is the only datum point which is solely a function of glass composition, and is unaffected by the past history of the glass or by fortuitous circumstances at the time devitrification is taking place. At the liquidus the first trace of

crystalline phase is in equilibrium with the glass; above the liquidus the glass will dissolve any such crystals which may have been formed at some previous time, but new crystals cannot form; while only below the liquidus is there a tendency for crystals to separate. The driving force causing this reaction is derived from the difference in free energy between the unstable glass and the stable aggregation of crystalline phases, and this force is opposed by a resistance of the nature of a viscosity. The dissociation in the liquid phase of the compounds which separate on devitrification diminishes the rate at which the devitrification equilibrium is reached, and increasing the complexity of the glass will have a similar effect. The excess in surface energy at the interface glass-crystal may have an influence at the instant of formation of the first infinitesimal crystal, but after the crystal has grown to a dimension appreciably greater than the sphere of molecular action the excess energy at this interface ceases to be of importance. The only surface-tension measurements which have been made on glass refer to the interface glass-air, and the excess energy at this interface has no necessary correlation with the divitrification process.

Effect of magnesia on the devitrification of a soda-lime-silica glass. GEORGE W. MOREY. *Jour. Amer. Ceram. Soc.*, **13** [10], 714–17 (1930).—The effect of magnesia on the devitrification of a certain soda-lime-silica glass has been ascertained. The initial glass had a composition $1.15Na_2O{\cdot}0.84CaO{\cdot}6SiO_2$, and tridymite separated as primary phase. On substitution of MgO for CaO, tridymite remained primary phase and the melting point was lowered, but the curve shows a double inflection. Addition of 2% of MgO lowered the melting point almost 200°, with the glass passing from the field of tridymite to that of $Na_2O{\cdot}3CaO{\cdot}6SiO_2$, but with more than 3% MgO, diopside became the primary phase, and the melting point rapidly increased.

Effect of alumina on devitrification of soda-lime-silica glass. GEORGE W. MOREY. *Jour. Amer. Ceram. Soc.*, **13** [10], 718–24 (1930).—The effect of Al_2O_3 on the devitrification temperatures of a soda-lime-silica glass approximately of the composition $Na_2O{\cdot}CaO{\cdot}6SiO_2$ has been studied in two series of experiments. In one of these CaO was partially replaced by Al_2O_3 until the final glass had the composition of the mineral albite, $Na_2O{\cdot}Al_2O_3{\cdot}6SiO_2$; in this series of experiments the melting point of the glass was first lowered, until the glass passed from the tridymite into the $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ field; then rose slightly to a maximum, fell until the glass entered the field of $CaO{\cdot}SiO_2$, and then rose rapidly until the field of albite was reached. Glasses near albite in composition are practically impossible to crystallize in the dry way. In the second series of experiments, Al_2O_3 was added to the same glass, and it was found that the fields of tridymite and $Na_2O{\cdot}3CaO{\cdot}6SiO_2$ were quickly passed through, with a smaller lowering of melting point than in the preceding series, after which the melting point rapidly increased with $CaO{\cdot}SiO_2$ as primary phase. It is shown that no generalizations can be made as to the effect of alumina on the devitrification of soda-lime glass. The problem is one of the freezing-point relations in a 4-component system, and in the absence of definite knowledge of the liquidus temperatures and corresponding stability regions in that 4-component system, general statements would probably be misleading. In addition, the devitrification of some 5-component soda-lime glasses containing both Al_2O_3 and MgO is discussed.

Fluoride interference in R_2O_3 determination. S. R. SCHOLES. *Glass Ind.*, **11** [9], 213–14 (1930).—When a glass sample has been decomposed by evaporating with hydrofluoric acid, erratic results are sometimes obtained in the estimation of iron oxide and alumina. An excess of sulphuric acid over the amount necessary to combine with the bases is essential; evaporation should also be completed over a flame until the dense fumes of sulphuric acid can be recognized. S. explains the interference of fluorine by the formation of a complex ion such as $-AlF_6'''$ or $-FeF_6'''$. E.J.V.

Influence of manganese oxide on some properties of glass. A. A. CHILDS, V. DIMBLEBY, F. WINKS, AND W. E. S. TURNER. *Ceram. Ind.*, **15** [3], 293 (1930); see also *Ceram. Abs.*, **9** [7], 516 (1930). W.W.M.

Granular glasspar. B. C. BURGESS. *Glass Ind.*, **11** [9], 215–16 (1930).—Granular glasspar, an innovation in the feldspar industry, is made granular to conform with the other granular materials used in glass manufacture. The Tenn. Mineral Products Corp. has developed a new process of grinding feldspar which makes only $^1/_{10}$ of the fines made by the present process. An objection to this process is that it cannot be used without increasing the iron content of the feldspar. An induction separator adaptable to the separation of feldspar was used. The iron analyses from the commercial tests were from 0.05% to 0.063%. The new product (1) enters the batch mix more evenly and perfectly; (2) lessens batch separation when used with other granular ingredients; (3) has a quicker and more uniform melt; (4) requires less heat, reduces melting time, and lowers production cost; (5) flows more freely to batch mixer; (6) prevents clogging of checkers; (7) is dustless in unloading, weighing, and mixing; and (8) is lower and more uniform in iron content. Illustrated. E.J.V.

Relation of particle size to melting of feldspar. A. K. LYLE. *Glass Ind.*, **11** [9], 211 (1930).—For use in glass, feldspar is ground to 20-mesh, and in most cases approximately 50% will also pass a 100-mesh screen. Twenty-mesh feldspar works satisfactorily but a coarser product would be just as good or a finer material, better. A standard 20-mesh feldspar was screened into 12 portions and a sample of each portion and of the original unscreened feldspar was made into a cone approximately 1 in. in diameter and 1 in. high. The 13 samples were fired to cone 10. Relatively small difference in particle size affects the rate of melting and the finer the particle, the faster the rate will be. The cone of the original unscreened feldspar behaved exactly like a cone of material slightly finer than the 120- to 140-mesh cone, and calculations showed it to correspond to a sample of 128- to 148-mesh, checking the actual result. The results show nothing definite regarding the behavior of feldspar in glass, but they indicate the possibility of positive results in a continued investigation with actual glass melts. Illustrated. E.J.V.

Selenium and tellurium. ANON. *Can. Chem. Met.*, **14** [8], 21 (1930).—Selenium exists in three allotropic modifications, amorphous, vitreous, and metallic. The last is obtained by heating vitreous selenium, the metallic phase forming at 217°C, with a specific gravity of 4.8. Selenium is used as a colorizer and decolorizer in glass and pottery industries, and for the production of ruby glass and ruby glazes in the ceramic industry. The selenium is added either as the metal or element or as sodium selenite in the proportion of about $^1/_2$ ounce to 1000 lbs. of sand, together with cobalt oxide to $^1/_8$ of its weight to correct the muddiness which remains after selenium decolorization. Metallic tellurium is used as a coloring agent in certain glass and ceramic ware. The price of selenium and tellurium in the U.S. in 1929 was $2.18 and $2.25 to $2.70 per pound, respectively. E.J.V.

New celluloid coatings. ANON. *Sprechsaal*, **63** [33], 632 (1930).—For the transparent coloring of celluloid, alcohol solutions of basic coloring substances or bases of coloring substances were used; with admixtures of insoluble color substances containing mineral pigment, only opaque masses were obtained. Celluloid and celluloid masses of nitro or acetyl cellulose can be made transparent by working the celluloid mechanically. In this way valuable colorings for glass and similar products are obtained. M.V.K.

Constitution of silicate melts. H. SALMANG. *Chem. Zentr.*, **1**, 423 (1930); for abstract see *Ceram. Abs.*, **9** [5], 386 (1930). (*B.C.A.*)

Fourcault glass industry. F. H. STANG. *Keram. Rund.*, **38**, 20–23 (1930).—

The importance of glass-batch composition in controlling viscosity, density, and expansion of the glass during working is noted. Inhomogeneity of batch and consequently of glass may result not only from curtailed, but also from prolonged batch mixing. Separation of constituents, especially raw batch from cullet, in filling bins and hoppers must be avoided. The disposition of machines in the drawing tank and the shape of the drawing tank is of importance. Three types are in general use: (1) the drawing tank as a continuation of the melting and refining tank with machines arranged one behind the other (2) the melting, refining, and drawing tanks forming a cross, the drawing tank being in three sections forming the cross-bar and head of the cross with machines in all three sections, and (3) small drawing tanks radiating as canals from the refining tank with one machine in each drawing tank. None of these types seems to have outstanding advantages. In case too many machines are drawing from one melting tank, it may be necessary to increase the length of the melting tank. The advantages of (1) higher temperatures for preheating tanks, (2) coating the inside of hot tanks with melted cullet before introducing batch, and (3) substitution of dolomite for calcite, or the slight increase in silica for prevention of devitrification, are noted. By the addition of alumina to an amount as great as 2.5% of the weight of the glass, improvements are noted in (1) resistance of the glass to heat shocks, (2) improvement in mechanical strength, (3) resistance to weathering and decomposition, (4) improvement in luster and polish, (5) increase in life of the tank block, and (6) practical elimination of devitrification. H.I.

Ultra-violet rays and glasses transparent to them. HUGO KÜHL. *Glashütte*, **60** [31], 563–64 (1930).—Ultra-violet glasses are usually CaO-Na_2O-SiO_2 or CaO-K_2O-SiO_2 glasses with as little Fe present as possible. Since raw materials are always contaminated with some Fe, the melting must be done in a reducing atmosphere. The iron is then present as a ferrosilicate which is transparent to the ultra-violet rays. When ferrisilicate is present the rays are absorbed; the ammount of absorption is a function of the ferrisilicate in the glass. The amount of iron in the glass must be small since the action of the ultra-violet light causes the ferrosilicate to change to ferrisilicate. Thus the ultra-violet in the sun is sufficient to cause a decrease in the amount transmitted by 2 to 5% within the course of several months. In making these glasses B_2O_3, Al_2O_3, BaO, and ZnO may be used with success. L.T.B.

Rate of stretching of glass filaments on heating. G. TAMMANN AND E. JENCKEL. *Z. anorg. allgem. Chem.*, **191** [1], 122–27 (1930).—Glass filaments were loaded with a constant weight and heated. When the relative stationary lengthening reached a value of 0.0002, the temperature t_w was reached. At this temperature, the physical properties such as specific heat, coefficient of expansion, etc., showed a break. This temperature falls in the softening zone and practically coincides with the temperature at which the glass becomes brittle. Mathematical relations between these temperatures, rate of lengthening, and viscosity of the glass are given. L.T.B.

Dependence of a few optical properties upon temperature in softening range of glasses. G. TAMMANN AND H. HARTMANN. *Z. anorg. allgem. Chem.*, **185** [3], 305–23 (1930).—A series of refractive index determinations were made on glasses of organic materials such as colophonium, cane sugar, and salicine. It was found that the refractive index varied linearly as the temperature in the highly viscous state and also linearly as the temperature in the glassy state in the vicinity of the softening point. These two lines are not parallel and cut each other at a temperature 2 to 3.5°C higher than the temperature at which the glass becomes brittle. In the highly viscous state, the angle of rotation of polarized light changes linearly as the temperature. It is difficult to measure. Under strain, a birefraction is caused in glass. The time required for the removal of this birefraction by heating the glass was measured. The

time decreased as the temperature was increased along a hyperbola whose asymptote lies near the temperature at which the glass becomes brittle. L.T.B.

Structure of glasses; the evidence of X-ray diffraction. J. T. RANDALL, H. P. ROOKSBY, AND B. S. COOPER. *Jour. Soc. Glass Tech.*, **14** [54], 219–29 (1930).—Vitreous and amorphous silicas consist largely of cristobalite crystals of about $1.5 \times 2.0 \times 10^{-7}$ cm. The vitreous and "amorphous" states are identical in structural unit, which is really crystalline. Glasses give rise to broad diffraction bands. X-ray films were examined with a Moll microphotometer to determine the positions of the bands with accuracy. Using Cu-Kα radiation, a single intense band at 4.33 Å has been obtained with vitreous silica corresponding to the strongest line of cristobalite. The band obtained by Parmelee and Clark at 4.33Å using Mo-Kα radiation was checked. A faint line at 1.5Å was also found. Precipitated or "amorphous" silica gives almost exactly the same pattern. Wollastonite glass probably consists of crystallites of pseudowollastonite, while sodium borate glass consists of small crystallites of $Na_2B_4O_7$. In commercial hard glasses, the silica remains in the form of cristobalite crystals. Oxides of boron and aluminium do not appear to enter into combination with silica while oxides of strongly positive elements such as calcium and sodium do so to the destruction of the silica lattice. Strained and unstrained glasses give identical patterns. The lattice of the glass crystallites is slightly larger than that of the large crystals, although the arrangement and number of atoms in the unit is the same. The density of the glass should be less than that of the crystals which is true for vitreous silica. Actually it is 2.20 for glass and 2.35 for cristobalite. An account is given for the indefinite melting of a glass as compared with a crystal. A suggested explanation is offered on the discontinuity of thermal expansion, and also the variation of viscosity of glass with temperature. The term "amorphous" has little meaning since glasses and "amorphous" bodies consist of units of about the same size and both are crystalline. G.R.S.

Manufacture of blue glass and decomposition of sodium sulphate by silica. B. BOGITCH. *Compt. rend.*, **190**, 794–96 (1930).—The manufacture of blue glass colored by an iron silicate corresponding to $4FeO \cdot Fe_2O_3$ is common practice, but the mechanism of the reaction is unknown. Mixtures of ferruginous sand and sodium carbonate give the blue color, but mixtures of ferruginous sand, sodium sulphate, and carbon do not. B. studied the decomposition of Na_2SO_4 by SiO_2 (or rather Na_2SiO_3) and the subsequent reduction to Na_2S, by CO_2-CO mixtures and by carbon. His results show that in the decomposition of Na_2SO_4 by Na_2SiO_3 and its reduction to Na_2S by CO_2-CO mixture, equilibrium is attained slowly and in the reduction by carbon it is never reached. In the manufacture of this glass, the concentration of Fe should be 0.7 to 0.8% and of CO 0 to 2% in the absence of sulphate and 9 to 12% in the presence of sulphate. R.H.E.

Preparation and purification of the tri-iodides of antimony and arsenic for use in immersion media of high refractive index. H. G. FISH. *Amer. Mineralogist*, **15** [7], 263–66 (1930).—Mixtures of piperine and iodides of antimony and arsenic have not been found suitable for determining the indices of refraction of mineral fragments due to numerous microscopic inclusions. Purification of the piperine and the iodides makes the media more satisfactory. Coarsely crystalline piperine of rather large fragments gives best results. Recrystallization from a filtered hot alcoholic solution removes the foreign material. Antimony tri-iodide was synthesized directly from metallic antimony and iodine. The crude tri-iodide was purified by dissolving in CS_2 at 45°C, adding powdered antimony, if necessary, to discharge the excess iodine dissolved and then decanting the supernatant liquid. This solution, protected from light, was cooled in ice water and the crystals produced were collected. A recrystallization was made. Crude arsenic tri iodide was prepared and purified by recrystallization as described for

antimony tri-iodide. To prevent decomposition when melts of the iodides and piperine were made, the mixture was not heated above 135°C. After cooling, the refractive indices of the mixtures were determined by means of a goniometer. G.R.S.

Spectrophotometric study of micas. TOYOFUMI YOSHIMURA. *Sci. Papers Inst. Phys. Chem. Research* [Tokyo], **11** [11], 1 (1929); *Sprechsaal*, **63** [35], 664 (1930).—The absorption of light of colored crystals and glasses was investigated spectroscopically by O. Weigel and G. Habich (*Neues Jahrb. Min. Beil*, **52**, 1 (1928)). The maximum shown in some curves is ascribed to the chromium, iron, manganese, etc., content in the investigated substances. In some materials no selective absorption was determined, but rather, continuous absorption, which was ascribed to the influence of dispersed particles in the colored substances. To clear up the question, spectrophotometric investigations on mica and on cobalt glass were made with a Hilger spectroscope, a Nuttig photometer, and a 100-watt tungsten point lamp for lighting the visible part of the spectrum. In spite of their coloring, all the micas investigated showed no absorption bands in the layers examined. The extinction coefficient was always greater in the thinner layers than in larger layers, the law of Lambert not being successful for these minerals. The extinction coefficient seems to produce a function of the absorbing thickness of the layer, which can probably be traced to the influence of the surface reflection in thinner plates of mica. The following micas were investigated:

	Kind	Locality	Color	Refractive index	2 E
I	Biotite	Suizawa	Brownish black	1.642	30° 31′
II	Biotite	Naegi	Greenish black	1.634_5	9° 40′
III	Muskovite	Doi	Pale green	1.596_5	61° 0′
IV	Muskovite	Suizawa	Pinkish	1.584_5	68°
V	Muskovite	Suizawa	Brownish	1.588	52° 10′

The extinction coefficients ($\epsilon = \frac{1}{d} \log \frac{1_o}{1}$; d = thickness of the layer) amounted to

	d(cm.)λ(μμ)	675	650	625	600	575	550	525	500
I	0.0025	296	328	376	408	492	528	592	636
III	0.135	4.74	5.18	5.18	5.18	5.35	5.77	6.22	6.66
IV	0.051	5.88	6.86	8.04	8.43	9.21	10.6	10.8	11.4
V	0.023	15.2	18.6	20.5	21.8	23.0	23.9	25.2	27.4
Cobalt Glass	0.022∼ 0.090	127	154	151	170	96.5	120.5	102	64.1

The curves of the extinction coefficients and the wave-lengths for mica showed no bands but decreased to shorter wave-lengths, while the absorption curves of cobalt glass showed definite bands and fulfilled the law of Lambert without exception. It was concluded from the results that the absorption curve of cobalt glass is produced by the molecules or complex molecules of cobalt in the glass, while the color in mica is brought about by certain dispersed particles which are found in a colloidal state in mica. M.V.K.

Increase in density of glasses after solidifying under high pressure and return to original density with increased temperatures. G. TAMMANN AND E. JENCKEL. *Z. anorg. allgem. Chem.*, **184**, 416–20 (1929); *Sprechsaal*, **63** [35], 666 (1930).—Glasses were put under a pressure of 5700 kg./sq. cm. at temperatures above that at which brittleness begins; after cooling, the density was determined. An increase in the density, which amounted to 5 to 8% in V_2O_5 containing B_2O_3 and P_2O_5, was found in nearly every case, and lay within the limits of error in $NaPO_3$, As_2O_3, and colophony. After heating, the original density returns. This behavior of glasses has some connec-

tion with the change of density of cooled glasses when heated. In a cooled piece of glass, the outer layers are subjected to compression strain and the inner layers to tension strain. When the bounds between the pressure and tension strains are shifted to the interior by heating, the density can increase; when the pressure in the layers with the tension strains falls, the density decreases. M.V.K.

Eye-protection glasses with metal coatings. OSCAR KNAPP. *Keram. Rund.*, **38**, 151–53 (1930).—The ordinary protective glasses absorbing ultra-violet and infra-red in which the absorbing medium is incorporated in the glass have two disadvantages: (1) the absorption of these rays increases the temperature of the glasses and the area between the glasses and the eye, and (2) spectacle lenses which differ in thickness in different spots have varying absorptive powers. A method of coating glass by cathodic sputtering of metals produces protective lenses free from the disadvantages mentioned. The removal of the undesirable wave-lengths is by reflection rather than absorption. The percentage transmission for certain wave-lengths depends upon the thickness of the coating. Platinum-coated glasses reflect all the ultra-violet up to 300$\mu\mu$, but very little more of the infra-red than of the visible. Some gold-coated glasses reflect all the ultra-violet up to 330$\mu\mu$, about 30% of the visible, and about 65% of the infra-red at 1200$\mu\mu$. Some silver-coated glasses permit transmission of about 45% of the visible rays, only about 20% at 1000$\mu\mu$, and 0 at 300$\mu\mu$. A mixture of gold and silver is darker than any of the foregoing for the visible rays, but excludes practically 100% of the ultra-violet and infra-red. Such glasses are also efficient in preventing the overheating of preparations, lenses, etc., in microprojection work. H.I.

Science in service of illuminating glass manufacturers. S. ENGLISH. *Gas Jour.*, **191** [3505], 209 (1930).—Sand and lime constituting 80% or more of the finished glass are natural materials and always contain a small amount of iron oxide giving the glass a greenish color. This is usually covered up by the pink color of manganese. Glass thus has two colors absorbing light throughout the whole range of the visible spectrum. If the iron can be reduced by one-half, the decolorizer can also be decreased by a like amount, and the resulting glass has a lighter and brighter appearance. During the past 3 years the color and brilliancy of British glass has been improved in this way. Where 14 oz. of decolorizer were formerly used only 9 oz. or less are now employed per unit of batch. In annealing ordinary glassware the power to resist variations of temperature has been improved by about 50%. Experiments directed toward heat-resisting glasses are being made. G.R.S.

Gold-ruby glass. E. ZSCHIMMER. *Sprechsaal*, **63** [34], 642–44 (1930).—Z. reviews the existing literature and describes investigations made by different authors on gold-ruby glass. As early as 1595, Libavious used gold for its preparation and Johan Kunckel prepared beautiful ruby glass, but the composition of this glass is not known exactly. Z. supposes that it was silicic acid 77.4%, boric acid 3.5%, sodium 14.4%, potassium 0.4%, clay 2.2%, lead oxide 1.3%, and arsenic 0.8%. Tests made with such a composition were successful. M.V.K.

Tellurium used in coloring glass. ANON. *Nat. Glass Budget*, **46** [17], 20 (1930).—Tellurium is a silver-white, lustrous, brittle, metallic-looking substance resembling antimony. It is used in the glass industry to produce blue and brown glass and glazes. E.P.R.

Pressing glass. ROY E. SWAIN. *Glass Ind.*, **11** [9], 204–205 (1930).—With the glass in the mold, the mold is placed beneath the plunger which descends and forms the inner surface of the article. This is accomplished by a toggle or a rocker-shaft and connecting rod arrangement. The plunger is quickly brought into contact with the glass, then with decreasing speed and increasing power, the glass is forced into the outer and upper portions of the mold. In a study of the flow of glass, making allow-

ances for the surface chill and the increasing viscosity near the surface, a thin article must require a greater amount of pressure to produce a given flow than a heavier article. Perhaps no two articles would plot the same weight and pressure curves, nor would a composite of a number of representative curves agree with the pressure curve plotted for the toggle. The general trend, however, is such that the pressure is able to make articles of varying weights in the same mold with but slight difference in exertion. In pressing, the spring pressure is used to hold the mold ring in place. In pressing fluted or ribbed articles, glass following the line of least resistance will first reach the ring in the heavier sections and the presser will often have to experiment to find the best way to pull the job to make it fill properly. Blisters are usually considered to be the fault of the gatherer but many of these blisters "press out," *i.e.*, come to the surface and burst during the pressing operation. The problem of temperature control can be found in every department of the glass factory. The mold designer and the mold maker study the molds to include all the kinks known to them to assist the presser in making the article for which the mold is intended but the presser must set up and regulate the wind, compressed air, and water coolers to get the desired results. Should the presser allow the mold to become too hot the glass may cling to the over-heated section and cause a scar on the mold that can only be removed by repolishing. Removing the article from the mold requires skill and thought. A large amount of pressed ware requires an additional operation in the blowing room such as knocking out bottoms of shades or reflectors, putting on handles, finishing, fire-polishing, etc. Illustrated. E.J.V.

Technical control in glass factories. S. ROLF. *Keram. Rund.*, **38**, 135–37 (1930).—The necessity for uninterrupted and detailed control, if it is to be of any value, is emphasized. H.I.

Development of photographic lens. H. W. LEE. *Glass Ind.*, **11** [9], 199–203 (1930).—The qualities of glass most important to the optician (besides transparency and stability) are refraction and dispersion. Refraction enables the optician to form an image with a lens; dispersion spoils that image with color fringes. The first "achromatic" telescope object glass was made in 1753 by Chester Moor Hall, who found that by combining a convex lens of crown glass with concave flint glass, it was possible to cure dispersion. After the invention of the "periscope" lens by Wollaston in 1812, other lenses with greater speeds were developed, the most important of the early forms being the rapid rectilinear or aplanat, which may be considered as the symmetrical assembly of two landscape lenses. After the systematic investigation of new types of glass by Faraday, Harcourt, Stokes, Schott, and Abbé, it became possible to design a photographic lens having a flat field, the type known as "anastigmat." The complicated types of lenses that have been developed are described. The aperture has been steadily increased until now it is possible to obtain a lens with aperture F/1.4. The possibilities of improvement in lenses through greater developments in optical glasses are discussed. Illustrated. E.J.V.

Justification of waste-heat boilers in continuous glass tanks. JOHN W. ROMIG. *Glass Ind.*, **11** [9], 206–209 (1930).—As far as glass-tank operation, tank cycles, and tank life are concerned, the application of waste-heat boilers presents no handicap if the installation has been carefully planned. The continuity of glass-tank operation gives an almost constant supply of waste heat for steam generation. Because of varying plant conditions, waste-heat installations may not be profitable in every plant. The factors involved in the economics are (1) amount of heat available for diversion through a waste-heat boiler and (2) steam pressure to be maintained. The amount of heat available depends upon (1) the quality of fuel burned, (2) the heat-reclaiming capacity of regenerators or recuperators, (3) the tank temperature, and (4) the loss in tempera-

ture of the waste products as they pass through the flues to the stack. Illustrated. See also *Ceram. Abs.*, **9** [10], 834 (1930). E.J.V.

Pneumatic conveying and dust control in glass plants. E. N. DE CONINGH. *Ceram. Ind.*, **15** [3], 294–95 (1930).—Pneumatic conveying was first installed for unloading soda ash from box cars to storage bins. One company owning three glass plants has adapted pneumatic conveyers to the present plant structures in two of them, but in the third, pneumatic conveyers have been made a major feature. Silica sand, soda ash, limestone, and salt cake are conveyed from box cars to storage bins. A vacuum of 18 to 20 in. of mercury is used and one operator can unload material at an average rate of 10 T. per hr. A hood over each storage bin discharge under which a negative pressure is maintained when loading the batch car controls dust at this point. A ten-compartment dust filter is also installed in this plant. W.W.M.

New laminated glass products announced by Triplex safety glass. ANON. *Nat. Glass Budget*, **46** [17], 17 (1930); *Amer. Glass Rev.*, **49** [48], 32 (1930).—Manufacture of two new products known as Artriplex and Ad-Triplex, making possible the use of color and design in laminated glass, has been announced by the Triplex Safety Glass Co. of North America. Two layers of selected glass, cleaned and coated with an adhesive, and a single layer of plastic material are brought together under high pressure and elevated temperature. The color is introduced by means of a colored plastic layer. By this method, the durable polished surface of the glass is combined with the brilliance of the color contained in the plastic. There are four distinct processes for producing the colored laminated glass. (1) The use of celluloid or plastic which has been colored previous to lamination. By this method, there is no limit to the number of colors or color combinations that can be produced. This single process permits the reproduction of stained glass effects, mottles, marbles, inlay woods, ordinary wood grains, and inlaid pearls. (2) Direct printing on the plastic layer. Line and mechanical designs of any sort and in any color can be reproduced. (3) Lithographs transferred directly to the plastic by the application of heat and pressure. (4) A process evolved from a development of silver and dark mirrors. The picture or design drawn by an artist is transferred to the mirrored glass by a process involving photography and a chemical preparation of the glass surface. The design obtained in this manner is etched on the glass and laminated with a plastic layer and another sheet of glass. The design then stands out clearly against a background of a silver or dark mirror. E.P.R.

New laminated glass. ANON. *Glass Ind.*, **11** [9], 219 (1930); for abstracts see *Ceram. Abs.*, **9** [10], 832, 833 (1930). E.J.V.

Nonsplintering glass. E. RADDE. *Kunststoffe*, **19**, 121–23, 153–55, 180–82, 200–205 (1929).—A review of the prior art, particularly the patented art, dealing with the manufacture, composition, and uses of nonsplintering glass is given. (*C.A.*)

Fused-quartz windows. ANON. *Glass*, **7** [7], 278 (1930); *Ceram. Ind.*, **15** [2], 208 (1930).—Through the use of clear fused-quartz windows in a deep-sea diving bell it has been possible to descend more than a quarter of a mile in the ocean. The windows are 3 in. thick and 8 in. in diameter. H.W.A.

Machine-blown bottles. E. P. PARTRIDGE. *Sprechsaal*, **63** [35], 666 (1930); for abstract see *Ceram. Abs.*, **9** [1], 23 (1930). M.V.K.

Decorative carved glass. ANON. *Amer. Glass Rev.*, **49** [45], 27–28 (1930).—One of the oldest firms in the country making a specialty of ornamental glass is the Rawson & Evans Co. Decorative carved glass is used in store fronts, valances, transoms, windows, doors, ceilings, window backgrounds, display cases, cabinets, etc. E.P.R.

Crystal glass. ANON. *Pottery Gaz.*, **55** [639], 1439–42 (1930).—Crystal glass is the result of a scientifically regulated fusion of sand, red lead, and potash, to which is

added a minute percentage of a decolorizing agent, which adds purity to the whiteness of the glass. After 36 hours' firing, a refined transparent, molten liquid is the result, and it is from this that handmade articles in crystal glass are produced. The process of making a crystal salad bowl is traced through the various steps of gathering the molten glass, shaping it, annealing the blank, rough cutting, smoothing, and engraving the piece. Illustrated. E.J.V.

Glass stops sun's heat. ANON. *Popular Sci.*, **117** [4], 36 (1930); for abstract see *Ceram. Abs.*, **8** [11], 801 (1929). E.J.V.

Development of glass sands in U. S. ANON. *Pottery Gaz.*, **55** [639], 1466–67 (1930); *Pit and Quarry*, **20** [11], 53 (1930).—Glass sand deposits have been found in southern Nev., one being cross-bedded sandstone and very extensive. Analyses indicate a silica content of 98.90%, iron oxide 0.05%, alumina 0.65%, and lime 0.05%. A deposit of high-grade glass sand has been reported in Washoe County. The development of glass sand deposits in the western States and the perfecting of methods for their purification and treatment should gradually lead to less dependence on foreign supplies and a desirable wider utilization of domestic sands. E.J.V.

Floor temperatures of industrial buildings. F. W. PRESTON. *Glass Ind.*, **11** [9], 210 (1930).—The comfort and efficiency of workers in buildings depends partly on the temperature of the solid surroundings, especially walls and floors. Comparisons of floor temperatures were made in buildings glazed with heat-absorbing glass as against buildings glazed with white glass. A study in which temperatures of the floor were measured in direct sunshine under white glass and under heat-absorbing glass showed that the heat-absorbing glass effects an extraordinary change in the floor temperature, reducing it nearly to "shade" or air temperature while white glass leaves it within a few degrees of sun temperature. E.J.V.

Glass skyscrapers. ANON. *Architect*, **14** [3], 239 (1930).—Outer walls of heavy brick and stone are replaced by glass and copper in a model building designed by Frank Lloyd Wright. G.R.S.

Manufacture of glassware. RENÉ CHAVANCE. *Mobilier et Décoration*, pp. 153–60 (April, 1930).—A visit to the glass factory of Genet et Michon, where the making of pressed glass has been highly developed, is described. The use of this glass in lighting equipment is illustrated. (*D.I.*)

Glass and the house fly. F. W. PRESTON. *Glass Ind.*, **11** [9], 203–204 (1930); for abstract see *Ceram. Abs.*, **9** [8], 630 (1930). E.J.V.

Glass jars exempt from duty. ANON. *Amer. Glass Rev.*, **49** [48], 16 (1930).—Glass jars imported into British Honduras to be used in the manufacture of toilet articles, cosmetics, or confectionery, and metal tops for such jars, are now exempt from duty. E.P.R.

Production of window glass in Mexico. GEORGE WYTHE. *Commerce Repts.*, **34**, 474 (1930).—The Vidriera de Monterrey, S. A., recently initiated the manufacture of sheet window glass, the first to be made on an extensive commercial scale in Mexico. E.J.V.

Glass factory for Jugoslavia. ANON. *Pottery Gaz.*, **55** [639], 1466 (1930).—After a study of the industrial relations of Jugoslavia, the St. Gobain concern has decided to erect a large glass factory in that country. E.J.V.

Glass industry in India. ANON. *Pottery Gaz.*, **55** [639], 1466 (1930).—The bangle industry of Firozabad made good progress during the year. The United Provinces Glass Works, Bahjoi, worked its sheet-glass plant for the first time during the year. Trained workmen were brought from foreign countries. Sheet glass of good quality has been manufactured and marketed. See also *Ceram. Abs.*, **9** [9], 800 (1930). E.J.V.

Glass industry in Japan. ANON. *Pottery Gaz.*, **55** [639], 1465 (1930).—Japan

has long been producing glass and glassware, but the real development of this industry in that country has taken place since the war. Production has increased to fill domestic requirements and also exports. E.J.V.

Exhibition at Zelezny Brod traces history of glassmaking in Bohemia. ANON. *Amer. Glass Rev.*, **49** [48], 16 (1930); for abstract see *Ceram. Abs.*, **9** [10], 891 (1930). E.P.R.

BOOK

Glass Industry. (Industria del vetro.) C. A. MAFFEI. Edited by U. Hoepli, Milano, 1930. 527 pp. Price 60 L. Reviewed in *Giorn. chim. ind. applicata*, **12** [6], 325 (1930).—This work in Italian reviews the most recent developments in the glass industry. The chapters of a descriptive nature are especially informative and interesting to the Italian glass industrialist. M.V.K.

PATENTS

Producing sheet glass. HORACE E. ALLEN. U. S. 1,772,448, Aug. 12, 1930. In an apparatus for producing sheet glass, a wedge-shaped slab having a trough therein, tanks associated with the ends of the slab to supply molten glass to the trough, bracket means for supporting the tanks and slab, stub shafts carried by the bracket means, and means to raise or lower the stub shafts to tilt the slab and tanks.

Separation of laminated glass. NEILSON EDWARDS. U. S. 1,772,800, Aug. 12, 1930. The method of separating laminated glass which consists in placing a sheet of laminated glass comprising sheets of glass and an interposed sheet of celluloid in a bath of cold water, gradually raising the temperature to produce a bubbly or porous structure in the celluloid, maintaining the temperature of the bath to permit the heated water to circulate in the bubbly or porous structure of the celluloid, gradually lowering the temperature of the bath, and finally removing the glass from the bath.

Fortifying frosted-glass articles. ROWLAND D. SMITH. U. S. 1,772,965, Aug. 12, 1930. A fortifying solution for use in connection with the frosting of glass articles which contains boric acid is given.

Glass-annealing leer. PERCY Q. WILLIAMS. U. S. 1,773,383, Aug. 19, 1930. An annealing leer comprising a leer tunnel, a traveling ware conveyer extending lengthwise through the leer, means forming with the conveyer a passageway extending lengthwise thereof beneath the conveyer, the conveyer forming an upper wall or cover for the passageway and formed with restricted openings for the passage of an annealing gas, means for heating the gas, means to cause a portion of the gas to flow through the passageway lengthwise thereof and a portion to move upward through the restricted openings, adjusting means to adjustably vary the distance through which the annealing gas is carried lengthwise of the passageway, and separate adjusting means to adjustably regulate the amount of the annealing gas passing through the restricted openings.

Feeding molten glass. KARL E. PEILER. U. S. 1,773,544, Aug. 19, 1930. The method of separating molten glass into mold charges, which includes discharging the glass through an outlet, suspending the discharged glass in successive masses by its adhesive contact with a support spaced below the outlet, and shearing a mold charge from each suspended mass at a plane spaced below the support.

Making articles of glassware. RAY C. COBEL. U. S. 1,774,871, Sept. 2, 1930. An apparatus for making an article of glassware with a handle thereon comprising a mold and a mold ring, the mold and mold ring having indentations therein designed to form a handle completely with an opening therein.

Making composite glass. JOHN H. FOX AND WILLIAM OWEN. U. S. 1,775,123, Sept. 9, 1930. Apparatus for applying heat and pressure to a set of sheets to be joined together, comprising a sheet-metal tank open on one side, stiffeners for the vertical side

walls in the form of commercial sections with inwardly projecting flanges extending around the interior of the tank and spaced one above the other, perforated plates supported on the inwardly projecting flanges and dividing the tank into a series of shallow compartments one above the other, a flexible container in each compartment opening through the open side of the tank, a header secured over the open side of the tank and slotted opposite the open ends of the containers, and means for applying hydraulic pressure to the tank.

Making plate glass. FREDERICK GELSTHARP. U. S. 1,775,125, Sept. 9, 1930. In combination, a glass tank containing a body of molten glass and open above a portion of the bath, a pair of horizontal driven sizing rolls above the portion of the bath, one of which has its periphery immersed in the body of glass while the other lies at a higher level so that it is out of contact with the body of molten glass, the end of the roll which lies in the glass having its ends tapered inward to provide an edge-holding means for the sheet as it is formed and the other roll having its ends tapered reversely, means for cooling the rolls so as to prevent the glass from sticking thereto, and means for supporting and carrying away the glass which is delivered by the rolls.

Severing molten glass. GEORGE R. HAUB. U. S. 1,775,199, Sept. 9, 1930. In a glass furnace a flow spout having a flow orifice, an explosion chamber disposed adjacent the orifice, means for intermittently feeding an explosive fluid to the chamber, means for igniting the fluid, a member movable by the pressure generated to release the gases to sever a glass charge, and means operated in the desired time relation to release products of combustion to retard the flow of glass.

Leer. LOUIS J. HARTLE. U. S. 1,775,281, Sept. 9, 1930. A leer having in combination a tunnel, a plurality of flues in heat-exchanging relation therewith, including flues above and below the tunnel, means for regulating the passage of heating fluid in spaced longitudinal portions of the flues for controlling the temperature in the tunnel, and means for transferring the heating fluid to portions of the lower flue after the fluid has emerged from the upper and lower flues.

Manufacturing bottles, etc. JOSEPH ARMSTRONG ANGUS. U. S. 1,775,381, Sept. 9, 1930. Mechanism for automatically transferring molded articles of glassware from one position to another, including a member mounted for rotation, trays slidably carried below the member, a bottle-supporting means carried above the member and connected to and slidable with the member, means for normally actuating the trays to a relatively inward limit position relative to the member, and a single element coöperating with the trays and serving to hold the trays against their operating means and in a projected position with respect to the member, the element being formed to permit the tray in a particular position incident to the rotation of the member to be moved to an inward limit with respect to the member by the actuating means for such tray.

Coating glass, etc., sheets. R. W. MUNRO, LTD., AND J. F. WILSON. Brit. 330,290, July 30, 1930. In apparatus for coating glass or other sheets in which the sheets are conveyed under yielding pressure between coating and presser rollers, the coating roller and a doctor roller for transferring the coating fluid to the coating roller are mounted in an adjustable bearing support.

Glass manufacture. L. MELLERSH-JACKSON. Brit. 330,366, July 30, 1930. Apparatus for circulating molten glass in a gathering pool or forehearth, particularly for use in connection with suction-gathering machines. The glass is moved by an impeller which has an alternating motion and coöperates with one or more stationary baffles arranged in the forehearth to cause the glass to circulate in a definite path.

Glass drawing. E. WESSELY. Brit. 330,465, July 30, 1930. Method of making plate or sheet glass whereby the sheet is drawn up vertically from a slot formed in a refractory block, which is partly submerged in the molten glass. The invention consists

in providing burners to heat the upper part of the walls of the drawing slot to prevent the formation of streaks in the glass sheet. Baffles are provided to direct the flames against the walls and water-circulating pipes are provided for cooling purposes. Specification 245,449 is referred to.

Gathering glass. L. MELLERSH-JACKSON. Brit. 330,706, Aug. 7, 1930. Apparatus for circulating molten glass in a gathering pool or forehearth, particularly for use in connection with suction-gathering machines. The glass is moved by an impeller, the lower end of which is submerged in the glass, and is moved in two intersecting paths at right angles to one another.

Cutting glass. E. A. HAILWOOD. Brit. 331,411, Aug. 20, 1930. A device for cutting glass comprises a wire helix which is heated by electricity and is arranged to be brought into contact with the glass. An arrangement for cutting glass tubes or removing the heads from blown ware comprises a holder made in two parts, hinged together and provided with an aperture which conforms to the surface of the article to be cut.

Safety glass. LIBBEY-OWENS GLASS CO. Fr. 681,039, Aug. 30, 1929. Glass is composed of 2 sheets of glass and an unbreakable sheet coated with a binding agent composed of a mixture of 2 or more thermoplasticizers of high boiling point and low vapor pressure such as a mixture of diamyl phthalate and dibutyl phthalate. (*C.A.*)

Safety glass. NEW G. & S. PROCESSES SYNDICATE, LTD. Fr. 681,507, Sept. 9, 1929. Transparent condensation products of PhOH and CH_2O, PhOH, CH_2O, and acetone or glycerol, or of PhOH, urea, and CH_2O are used for uniting the layer of organic material to the 2 sheets of glass. Fr. 681,508 describes a vacuum press for uniting the sheets. (*C.A.*)

Glass-annealing furnace. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES. Ger. 497,742, Dec. 28, 1926. (*C.A.*)

Heavy Clay Products

Contributions to the study of florescence. I. W. ANGUS MCINTYRE AND R. J. SCHAFFER. *Trans. Ceram. Soc.* [Eng.], **28** [8], 363–73 (1929).—The word "efflorescence" indicates the deposits of soluble salts which frequently form on the surface of masonry and brickwork on exposure to weather. This visible occurrence is only one manifestation of the phenomenon, and salts can crystallize in the body of the material without appearing on the surface and either may occur separately or together. The behavior of salts in the two positions may occasionally be different. It is proposed, therefore, to use the word "florescence" to cover the general phenomenon of the crystallization of soluble salts in building materials, restricting the old term "efflorescence" to crystallizations upon the surface; while to describe the salts concealed in the body of the material, the word "cryptoflorescence" is suggested. The majority of florescences consist of sulphates of the alkalis and alkaline earths but the composition can vary within wide limits. In ceramic ware, the salts which are present in the material when it is erected are responsible for a great deal of the florescence which is observed. In part, these may be present as such in the clay or in the tempering water, or they may be produced during the course of manufacture. Florescences may originate in the jointing material. Brick laid in cement mortar effloresce badly while similar brick laid in lime mortar do not. There are considerable grounds for belief that florescence can frequently be traced to the use of Portland cement mortars. Since florescences cause considerable damage to masonry and brickwork, it is desirable that they should be removed; but the use of chemicals for this purpose is to be deprecated. The continual action of rain water exerts a beneficial action, but in sheltered positions the salts may persist for long periods. Washing at intervals with water, to supplement the natural action of rain, seems to be the only method of retarding the decay of building materials. R.F.S.

Contributions to the study of florescence. II. Evaporation of water from brick. L. F. COOLING. *Trans. Ceram. Soc.* [Eng.], **29** [2], 39–52 (1930); for abstract see *Ceram. Abs.*, **9** [4], 276 (1930). R.F.S.

Efflorescence in brick. A. PELLACINI. *Corriere ceram.*, **11** [7], 285–89 (1930).—Efflorescence in clays containing sulphates of calcium, soda, potassium, and magnesium can be prevented by firing to high temperatures, but the difficulty of maintaining such high temperatures uniformly throughout the kiln and the cost of fuel are against this method. The cause of efflorescence is sometimes traced to the sulphates and impurities in the water used in mixing the clays or during firing from the flue gases. Very high pressure can be used to eliminate efflorescence; the use of barium is also recommended for clays containing sulphates although the cost runs rather high. Clays containing iron oxides often show yellow-white discoloration after firing. These clays also contain sodium chloride which has a specific action on iron oxide during firing and affects the color of the clays. M.V.K.

Sand for brick and mortar. K. A. GOSLICH. *Tonind.-Ztg.*, **54** [66], 1079–82 (1930).—A more exact knowledge of the sand used for brick and mortar is needed. The general idea that quartz sand produces the best solidity and should be used only is wrong. Investigations of Feret with porphyry, granite, sandstone, marble, ground glass, brick fragments, etc., showed that these materials can be used with success for brick and mortar instead of sand. The size and shape of the sand grain affects the quality of the mortars; also the character of the surface of the granules, since rough surfaces stick better. The question of loam or clay contents in sand is unsettled, although tests showed that a 3% addition of clay raised the solidity of mortar (O. Graf), and that loam affects the setting agent in its jell state only (R. Grün). When mixtures of sand and clay are sumped, clay diffuses into a colloidal form and coats the separate sand grains. It is therefore important to wash the sand before using it. Tests showed that the resistance to pressure of unwashed sand in a mixture of 1 part of Portland cement to 3 parts of sand amounted to 166 kg./sq. cm., while with the washed sand the resistance was 233 kg./sq. cm. (Urbach); on the other hand when clay is deposited in the spaces between the sand grains, which is sometimes the case with natural sand, the density and solidity of the mortar are increased. M.V.K.

Clay as foundation for structures. ANON. *Canadian Eng.*, **59** [6], 217 (1930).—Clay is the most variable of all materials in supporting properties. Ability to carry loads without undue settlement may vary from 1 to 7 T. per sq. ft. Studies of behavior of clays under pressure begun 20 years ago by Terzaghi, indicate that pressure and moisture content of clays are as definitely related as stress and strain in solid bodies. Recent experiments by Housel, Univ. of Mich., show that clay may, under some conditions, behave as a plastic solid, while under others as a viscous liquid. The carrying capacity of an area is apparently a function of the area and of the perimeter of the plate. The resistance is made up of two separate factors, one being dependent upon the perimeter of the area, called perimeter shear, and the other dependent on pressure upon the area itself. The effects of perimeter shear and pressure upon unit area may be separated and a simple straight-line formula has been presented to assist in determination of loads in practice. G.R.S.

Light-weight brick. W. D. RICHARDSON. *Clay-Worker*, **94** [2], 103 (1930).—Structurally, advantages of light-weight brick are their greater insulating or nonconductive qualities; also walls of such brick have less weight and hence less strain on foundations and frames. Commercially, light-weight brick have the decided advantage of lower freight charges. They are more easily handled by brick-layers, which means that brick may have larger bulk or cubic contents, with same weight, and the cost of laying be less per square foot of space or cubic foot of wall than with present sizes. Several ways

of making light-weight brick are discussed. The national standard size brick (25 x 12 x 6.5 cm.) in Germany are being made with 105 vertical holes. Another ingenious invention by Germans closes these holes automatically at the ends, giving the appearance of a solid brick. Illustrated. See also *Ceram. Abs.*, 9 [3], 186 (1930). E.J.V.

Tests bring out interesting data on strength of brick. ANON. *Brick Clay Rec.*, 77 [5], 272 (1930).—Out of 85 sets of clay and shale brick samples tested, 5 sets ran more than 15,000 lbs. per sq. in. in compressive strength, 18 sets more than 10,000 lbs. per sq. in., and a total of 58 sets more than 4500 lbs. per sq. in. The requirements for grade "A" brick is 4500 lbs. per sq. in., but almost 75% of the samples submitted have exceeded these requirements. In general, clay and shale brick far surpass any competing material in strength. Twenty-one sets of samples were below 4500 lbs. per sq. in. in compressive strength and only 6 sets (admittedly salmon brick) developed less than 2500 lbs. per sq. in. E.J.V.

Controlling shrinkage and culls. H. L. LONGENECKER. *Brick Clay Rec.*, 77 [4], 206–207 (1930).—The two principal sources of loss in face brick manufacturing are (1) from brick which do not shrink to the standard length and (2) brick which are off-color. Methods now in use to control shrinkage were adopted at a time when production had to be maintained first of all. In almost every clay pit which has been used for a number of years there are several different kinds of clay or shale from the standpoint of shrinkage. To prevent loss due to improper shrinkage, the exact shrinkage of each clay encountered in a pit should be known so that the various clays can be properly blended. E.J.V.

Haydite and metal facing, a new building product. ANON. *Brick Clay Rec.*, 77 [6], 320–22 (1930).—Cast stone and cement products which are porous and nonresistant to weather are now being made impervious by applying a coat of metal to the surface of the product. Its makers, the Maul Co. of Detroit and Chicago, claim strength and lightness and other properties for building uses. The metal coating is sprayed on by a special gun which is so constructed that there are streams of air, oxygen, and acetylene leading into the nozzle. The metal is fed through a hole from the rear of the gun into this nozzle which serves as the oxyacetylene torch, melting the metal. The air, which is introduced at a pressure of 50 lbs. per sq. in., atomizes the particles and drives them from the gun so that when the mist strikes the object the metal is deposited. The product is a regular cast stone and is so manufactured. A clay product, Haydite, is used in the aggregate in order to reduce the weight of the material and to give it insulating properties. Illustrated. E.J.V.

Steel combines with brick for better pavements. W. H. MOSELEY. *Brick Clay Rec.*, 77 [5], 260–62 (1930).—A new design in paving methods combines steel sheets and brick. The steel sheets are laid as a base upon which a mastic cushion and brick are laid. This combination of steel with brick will make possible a pavement of low first cost, with a life of from 50 to 100 years. It may be possible to lay this pavement as cheaply as is done with the present concrete roads. Illustrated. E.J.V.

Filler strips for laying paving brick pavements. DON A. WEBER. *Brick Clay Rec.*, 77 [4], 213 (1930).—W. presents an idea for employing an asphalt filler strip between paving brick. After a reasonable area has been finished, this could be gone over with a pavement heater so as to flow the asphalt filler strips, making a perfect bond between the brick and waterproofing the pavement in good shape. The body of these strips can be governed by chemical research so that this material will be firm enough to handle and also to govern the penetration and fluxing action of the heat, which is later applied. E.J.V.

Moisture loss in sewerpipe kilns. ROBERT L. BLESSING. *Brick Clay Rec.*, 77 [4], 208–209 (1930); see *Ceram. Abs.*, 9 [9], 736 (1930). E.J.V.

Standardization of brick units. W. D. RICHARDSON. *Clay-Worker*, 94 [2], 107–

108 (1930).—Since the movement for the adoption of standard sizes of masonry units and masonry openings, together with standard thickness of mortar joints, has been well started and doubtless will continue until brought to some definite conclusions in the near future, it is time for brick and structural clay tile manufacturers to give consideration to changes that may be made in the sizes of their products. A consideration of the question indicates that one solution would be the adoption of a larger size brick, though not necessarily a heavier brick. The standard dimensions of brick in the leading countries of Europe and the number of brick per cubic foot of wall structure laid up with a uniform mortar joint of $^1/_4$ in. in each country are given. Increasing the thickness of American brick to $2^3/_4$ in. seems to be one solution, and in the case of high buildings the use of brick $11^3/_4 \times 3^3/_4 \times 2^3/_4$ in. would help. Considerable thought must be given to this subject before final action is taken. E.J.V.

Essentials of good brickwork. HUGO FILIPPI. *Jour. West. Soc. Eng.*, **35** [4], 276–91 (1930).—F. reviews the work done by the Bureau of Standards on brick walls and discusses tests of brick and mortar, types of brickwork, absorption, fire resistance, and efflorescence. He summarizes the general rules which must be observed in order to obtain good brickwork, and concludes that more attention should be paid to workmanship and the mortar used. A discussion by C. C. Whittier is presented at the end of the paper. W.W.M.

Coating brick with any color. F. W. FITZPATRICK. *Brick Clay Rec.*, **77** [4], 202–203 (1930).—F., a consulting architect, has an invention whereby he can apply any color on face brick or even common brick which will have a depth and completeness not commonly found on coated products. Any of the ordinary low-priced face brick, or even common brick, as it comes from the kiln, can be used. An enamel facing of any color is put on and the cost will not add over $6.00 to the manufacturing cost. E.J.V.

Colors in clay products. ANON. *Brick Clay Rec.*, **77** [5], 271–72 (1930).—The Sheffield (Iowa) Brick & Tile Co. is producing vari-colored face brick as developed by the process of the Ceramic Development Corp. from the original Poston process. The colors are produced by applying to the surface of the brick a commercially prepared frit, the main constituent of which is a coloring oxide or oxides, depending on the color which it is desired to produce. The frit is mixed with clay from the company's own pit in varying amounts (between 1 and 5 lbs. of frit per 100 lbs. of clay). The frit and clay (mixed) is applied to the surface of the column as it emerges from the stiff-mud machine by means of a vacuum which is induced by steam jets, the high steam pressure serving to drive the particles of frit into the surface of the clay where they are firmly embedded. After the color is applied the brick are handled in the usual manner, the color having no effect on drying or firing operations. Illustrated. E.J.V.

Survey of face-brick industry. ANON. *Clay-Worker*, **94** [2], 109 (1930).—The details of a survey made by the American Face Brick Assn. of the face-brick industry are given. E.J.V.

Costs of limestone. ANON. *Brick Clay Rec.*, **77** [4], 214 (1930).—The American Face Brick Assn. has made a survey to determine comparative costs of face brick and limestone exteriors. Limestone exteriors for large buildings were found to cost three times as much per sq. ft. of surface (excluding windows) as face-brick exteriors. Some of the data are presented. E.J.V.

Are clay products in danger? SIDNEY F. HECKERT. *Brick Clay Rec.*, **77** [5], 274–76 (1930).—(Reply to the article by A. E. Fountain, Jr. (see *Ceram. Abs.*, **9** [10], 844 (1930)). H. disagrees with F. in the statement that no advance has been made in the clay products industry, with citations of advances made in handling structural tile and in the use of clay products. Illustrated. E.J.V.

Plant ideas. J. WHITAKER. *Brick Clay Rec.*, **77** [6], 324 (1930).—A home-made

locomotive for clay hauling, elimination of derailment of locomotives, methods of re-railing them, a pump for the clay pit, and a portable watersmoking fan are given. E.J.V.

Colonial type brick made by new process at Alliance. ANON. *Clay-Worker*, **94** [2], 101 (1930).—The Alliance Clay Products Co. has developed a machine-made Harvard type brick, made by the stiff-mud process and resembling handmade New England product. All colors in which the New England brick are made can be duplicated by the new machine process. Characteristic marks of the genuine hand-made brick are secured and the brick hold the superiority of stiff-mud machine-made brick over the old-fashioned product. E.J.V.

Glen-Gery Shale Brick Co. ANON. *Clay-Worker*, **94** [2], 91–98 (1930).—The Glen-Gery Shale Brick Co., Reading, Pa., is the largest producer of shale face brick in the East, operating four factories with the total annual production of more than 100 million brick. Some of their product is made by the stiff-mud process and the newer lines are soft mud. Illustrated. E.J.V.

Roanoke-Webster Brick Co. JOHN W. WHITTEMORE. *Brick Clay Rec.*, **77** [5], 264–70 (1930).—This brick plant at Roanoke, Va., has been rebuilt with modern equipment and arrangement. The plant has a daily output of 60,000 bricks, with smooth and texture face brick in reds, greens, and other flashed colors, and also common brick. Illustrated. E.J.V.

Early brickmaking and some old brick buildings in Virginia. II. ELLIS LOVEJOY AND H. B. HENDERSON. *Clay-Worker*, **94** [2], 104–107 (1930); see also *Ceram. Abs.*, **9** [10], 844 (1930). E.J.V.

Modern brickworks. ANON. *Tonind.-Ztg.*, **54** [58], 953–63 (1930).—Seven modern brick and tile plants of Germany are described. Photographs and diagrams illustrate the methods of production in the plants and show the use of brick and tile in modern German architecture. M.V.K.

BOOK

Modern Practical Masonry. A Comprehensive Treatise on the Practice of the Various Branches of the Craft. E. G. WARLAND. Price 25s. Reviewed in *Engineering*, **130** [3371], 223 (1930); for abstract see *Ceram. Abs.*, **9** [9], 738 (1930). A.A.

PATENTS

Building material and its applications. LÉON ATTHENONT. U. S. 1,773,658, Aug. 19, 1930. A building construction comprising a series of hollow brick, each showing a longitudinal aperture, the brick being arranged with their apertures in alignment, armatures grouted outwardly to the brick and a projecting joint plate arranged between adjacent brick and provided with passages for the armatures.

Making paving brick. JACOB NESSLY PORTER. U. S. 1,773,857, Aug. 26, 1930. A machine for making paving brick, comprising a forming die having spaced slotted portions in its upper wall adapted to provide a clay column with spaced longitudinal ribs on its upper face, a traveling belt for receiving the clay columns, spaced standards at opposite sides of the belt having rearwardly opening shouldered sockets therein, a freely floating frame fitting at its forward end between the standards, a roller mounted in the frame and having spaced transverse peripheral ribs adapted for embedding in the ribs of the clay column to form spaced pairs of spaced projections on the clay column, and a rod extending through the forward end of the frame and extending therebeyond for engagement in the sockets of the standards for detachably and pivotally connecting the frame to the standards.

Brick crate. EDWARD W. OSTRANDER. U. S. 1,774,839, Sept. 2, 1930. In a crate of the class described, a base, a top disposed above the base, antifriction devices

carried by the top, flexible elements fixed to the base and extended upwardly above the top in contact with the antifriction devices, and a suspension member connected to the flexible elements and located above the top, whereby when the crate is suspended, the flexible elements will move over the antifriction devices and tend to force the top down and cause the material in the crate to be pressed between the top and the base.

Arches, conduits, tunnels, etc. S. J. HIBBARD. Brit. 330,682, Aug. 7, 1930. A hollow structure having an inclined arched roof is built from blocks which are tapered both laterally and longitudinally, and are laid with the smaller ends together with the lowest blocks of the arch resting horizontally on parallel bases.

Building materials. ERIK C. BAYER. Ger. 499,405, Feb. 19, 1928. Addition to 421,777. Ger. 421,777 describes the manufacture of porous building materials by mixing cement, mortar, etc., with water to which a foam-producing substance has been added. This method is now improved by hardening the products in high-tension steam. (*C.A.*)

Refractories

Fire clays. Some fundamental properties at several temperatures. R. A. HEINDL AND W. L. PENDERGAST. *Jour. Amer. Ceram. Soc.*, **13** [10], 725–50 (1930); for abstract see *Ceram. Abs.*, **9** [3], 190 (1930).

Sand-lime (silicate) brick. E. M. ROMANOVSKII. *Vestnik Ingenieurov* (Supp. Ingenieurno-Stroitelnoe Delo III) [Moscow], July–Dec., 1–9 (1929).—Statistical data are given on silica lime production in Russia including information on Russia's 31 operating plants. Methods and equipment used in manufacturing sand-lime brick are discussed. (*C.A.*)

Electrical resistance of refractory materials at high temperatures. KARL WERNER. *Sprechsaal*, **63** [29], 537–39; [30], 557–59; [31], 581–83; [32], 599–601; [33], 619–23 (1930).—The materials investigated were practically nonconductors at low temperatures but lost this property at high temperatures. The purpose of these researches was to investigate the amount of the electrical resistance in a temperature field beginning with the temperature at which these materials cease to be nonconductors, for which the limiting value of about 1,000,000 ohm/cu. cm. was taken, and ending at 1600°C, as this temperature is the highest temperature to which these materials are generally exposed in practical use. The decrease of the resistance in all these materials at lower temperatures is much greater than at higher. When graphically represented, a definite typical curve results, and with the values of the logarithm of the electrical resistance protracted on one coördinate, and on the other, the reciprocal values of absolute temperature, a straight line can be drawn from the values found. The electrical resistance is lowered in proportion to the decrease in the water absorbing power of a body or the decrease of the pore space in the apparent volume of the body. It was necessary, therefore, to investigate the extent of the regular relationship between the electrical resistance and the water-absorbing power. The data for the substances investigated, silicic acid, alumina, lime, magnesium, and grog are represented in a table. In the top row the table gives the capacity of the absorption of water of each substance of the four series of tests carried on; in the second, the decrease of the capability of absorption in relation to the value of the first series of tests; and in the third, the real volume. Under the heading "absolute" follows the electrical resistance at the temperature indicated and the decrease in per cent for the separate tests. The "calculated" values are also given. These values show that the difference in the electrical resistance of the same substance conditioned by a different absorbing power decreases with the increase of temperature and is in no regular relationship with the decrease of values of the capability of absorbing water. Although the

capability of absorption of water given refers to room temperature, the investigations undertaken here took place at the temperatures from about 600 to 1600°C. If one assumes that the values for the capability of absorption of water of a body of one structure which does not change at different temperatures (as ceramic bodies possess) and further that the proportion of the capability of absorption of water of two such bodies remains constant at all temperatures, then, with the hypothesis that the pores in the bodies are uniformly distributed, those values for the electrical resistance which a completely dense body must have can be ascertained for all tests by calculation. These values should be the same for the four series of tests, but as is seen from the table under the heading "calculated" values, this is not the case. The values are nearer than the "absolute" values but there is no equality. It is therefore assumed that the above-mentioned hypothesis cannot be admitted. A comparison of the results of the experiments on separate substances follows. The decline in electrical resistance of silicic acid is rapid at proportionately lower temperatures; but becomes less rapid with further increase of temperature. At 1600°C, however, silicic acid still possesses the considerable resistance of about 9000 ohm/cu. cm. The resistance of alumina begins to decrease perceptibly first, between 900°C and 1000°C and falls rather sharply to 4700 ohm/cu. cm. at 1600°C. Lime and magnesium which are similar in their behavior possess even smaller resistance. Their resistance begins to decrease perceptibly between 900 and 1000°C and falls at 1600° to 1400 ohm/cu. cm. in magnesium and 1200 ohm/cu. cm. in lime. Of the materials investigated, fired-clay substance possesses the smallest resistance. Its resistance at 700° has already fallen to about 500,000 ohm/cu. cm. and at 1600° is about 800 ohm/cu. cm. If the results of the tests on materials with admixtures of flux are compared with the results of the corresponding pure materials, the resistance of the former is considerably lowered. Pure fired-clay substance at 700° has almost 9 times as great a resistance as the same substance with an addition of 1.0% Fe_2O_3, or 15 times as great with an addition of 2.0% Fe_2O_3. At higher temperatures, the differences are less marked. The pure substance at 1600° has a resistance greater than the double of the substance with 1.0% Fe_2O_3 and almost 3 times greater than the substance with 2.0% Fe_2O_3. The three test samples compared have, however, a different water-absorbing power; the bodies of pure fired-clay substance have an absorbing power of 6.8%; bodies with 1.0% Fe_2O_3, 5.2%; and with 2.0% Fe_2O_3, 4.2%. Pure silicic acid with an addition of 2.0% CaO or 1.0% Fe_2O_3 is similar to fired-clay substance in the lowering of the electric resistance. But there is a difference in the kind of the decrease inasmuch as at 600° pure silicic acid has only a resistance of about 24% greater than the silicic acid with an addition of 1.0% Fe_2O_3. Besides, pure silicic acid at 1600° has a resistance almost 5 times greater than that containing 2.0% CaO, and almost 9 times greater than silicic acid with 1.0% Fe_2O_3. Here also the test samples of pure silicic acid have an absorbing power of 13.5% while the silicic acid with additions has only 7.1%. If the electrical resistance of pure silicic acid in crystalline state is compared with the same in an amorphous form, no difference in the kind of decrease is seen between the electrical resistance and temperature in both modifications. Amorphous silicic acid, however, has a greater resistance than the crystalline at lower temperatures, but the resistance of the first diminishes much more rapidly with an increase in temperature. At 1000°C, the electrical resistance of both acids is almost equal, but in the amorphous modification at higher temperatures it falls considerably below the value of the resistance of the crystalline acid. Due to the fact that the samples used, including the silica and fireclay blocks, have more or less an accidental structure and composition, the values found vary greatly and it is not possible to determine the average values for the separate materials. An experiment is made here to ascertain the specific electric resistance of refractory materials. M.V.K.

Tests of refractory materials under pressure at high temperatures. P. P. Budnikoff, I. S. Smeljansky, and V. I. Endowitzky. *Ceramics and Glass*, **6** [4], 192–95 (1930).—A description of tests with refractory materials under a pressure of 1 kg./sq. cm. at high temperatures is given. The experiments were made in electric kilns of Steger and Hirsch-Hecht. Grog blocks began to deform at 1250 to 1350°. M.V.K.

Chemical analysis of refractory materials. W. König. *Tonind.-Ztg.*, **54** [60], 995–96; [63], 1041–42; [64], 1055–57 (1930).—Two series of experiments were undertaken to find out the most satisfactory method of analyzing refractory materials. The methods are described and results tabulated. M.V.K.

Contribution to the ceramics of refractory materials. IV. System ZrO_2–BeO. Otto Ruff, F. Ebert, and E. Stephan. *Z. anorg. allgem. Chem.*, **185** [1], 221–24 (1929).—A series of compositions of the two oxides were mixed and heated to melting. No compounds or solid solutions of the two were found in the system. A eutectic exists at 40 to 45 molecular per cent of BeO. It melts at 2180°C. BeO is volatile from the melts as evidenced by growth of hexagonal crystals of pure BeO in the cooler parts of the furnace. BeO makes a good ceramic material. Very hard and fairly dense crucibles were made, which were in excellent condition after a large number of melts at 2100°C. For Part III see *Ceram. Abs.*, **9** [2], 108 (1930). L.T.B.

Change of quartz to tridymite in silica blocks. P. P. Budnikoff and I. S. Smeljansky. *Feuerfest*, **6** [4], 60 (1930); for abstract see *Ceram. Abs.*, **9** [7], 540 (1930). L.T.B.

Rate of solution of MgO burned at various temperatures. Peter P. Budnikoff. *Z. anorg. allgem. Chem.*, **191** [1], 79–86 (1930).—$MgCO_3$ is usually burned between 800 to 900°C. At lower temperatures it still contains considerable CO_2 and above 900°C it is usually dead burned. The purer the $MgCO_3$ the more rapid the hydration of the burned MgO. It was the purpose of these studies to determine the rate of solution of pure MgO by the electroconductivity method. $MgCO_3$ was burned for 3 hours at various temperatures between 700 to 1300°C. The electric conductivity was measured during stirring of a solution containing 0.75 g. MgO at 20°C. The most rapid rate of solution was obtained for pure MgO when burned at 800°C, as measured by the maximum conductivity which was attained in 2 minutes. MgO burned at 700°C reached the maximum conductivity at 5 minutes and MgO burned at 1200°C, at 3 hours. For natural magnesite the maximum was reached most rapidly when burned at 850 to 900°C. MgO burned at 1000°C had not reached the maximum conductivity at 24 hours. Pure MgO with additions of 1, 3, and 5% Fe_2O_3 was then burned. The behavior was somewhat irregular and showed that Fe_2O_3 was an important factor in decreasing the solubility of MgO and also in affecting the rate of solution. 1% SiO_2 added to pure MgO increases the actual solubility considerably but the rate of solubility decreased as the temperature of burning increased. Greater amounts of SiO_2 decreased the solubility of MgO. L.T.B.

Melting diagrams of refractory oxides. H. v. Wartenberg and H. Werth. *Z. anorg. allgem. Chem.*, **190** [1], 178–84 (1930).—A series of melting temperature determinations were made in the following systems in a ZrO_2 furnace and crucible heated with an oxyacetylene blast. Temperatures were measured with an optical pyrometer. *System BeO–ZrO_2.* BeO melts at 2570°C. The composition of one compound found in the system is $3BeO{\cdot}2ZrO_2$ and it melts at 2550°C. This compound forms a eutectic with BeO which melts at 2090°C and a eutectic with ZrO_2 which melts at 2050°C. *System MgO–ZrO_2.* One compound, $MgO{\cdot}ZrO_2$, was found which melts at 2130°C. It forms a eutectic with MgO which melts at 1550°C and a eutectic with ZrO_2 which melts at 1600°C. *System BaO–ZrO_2.* One compound, $BaO{\cdot}ZrO_2$, exists which melts at about 2700°C. *System SrO–ZrO_2.* One compound, $SrO{\cdot}ZrO_2$, was found which melts

above 2700°C. It forms a eutectic with SrO which melts at 2200°C and a eutectic with ZrO_2 which melts at 2125°C. *System Cr_2O_3–ZrO_2.* Cr_2O_3 volatilizes readily and also reduces so that it is difficult to work with this compound. The melting point as determined by Ruff at 2080°C is too low but the difficulties mentioned above did not allow the authors to determine it accurately. It must lie above 2200°C, however. It forms no compound with ZrO_2. There is a eutectic in the system which melts at 2300°C.

L.T.B.

Formation of mullite in refractories. P. P. BUDNIKOFF AND B. A. HISCH. *Zhur. Prikladnoĭ Khim.*, **3**, 21–24 (1930).—Furnace lining made of a mixture of clays which was fired at 1300° analyzed SiO_2 57.0–58.0, Al_2O_3 36.4–37.3, Fe_2O_3 1.5–2, and CaO 1.5–1.9%. After 6 months' service in a coal-fired furnace its composition changed to SiO_2 49.38, Al_2O_3 28.54, Fe_2O_3 20.82, and CaO 0.91%. Microscopic examination revealed the presence of a large number of crystals of mullite with embedded crystals of FeO. Under certain conditions formation of mullite in refractories is favored by Fe compounds. Expert firing leads to the formation of a surface film on the refractory material and lengthens the time of its service. The life of refractories is also prolonged if the raw material after the usual firing procedure is subjected, for a short length of time, to the action of a still higher temperature in a reducing medium. (*C.A.*)

Structural features of raw materials for silica brick. P. JUDINSON. *Refrac. Jour.*, **5** [59], 424 (1930); for abstract see *Ceram. Abs.*, **9** [2], 107 (1930). E.P.R.

Firing of a fine-grained clay to chamotte. ANON. *Feuerfest*, **6** [4], 51–58 (1930).—Fine-grained clay should be fired in a rotary kiln not feeding the clay too fast. To reduce costs the kiln may be speeded up somewhat, or the clay may be briquetted and then fired and crushed. This latter process, however, would be costly. L.T.B.

Firing of a fine-grained clay to chamotte. K. BUHLMANN. *Feuerfest*, **6** [7], 102 (1930).—In answer to this question as proposed in the preceding abstract, B. claims that it is unprofitable to work the clay into large lumps before firing. L.T.B.

Sillimanite. ANON. *Blast Fur. Steel Plant*, **18** [9], 1505 (1930).—Cyanite, sillimanite, and andalusite are three minerals of essentially the same chemical composition, and with similar treatment the products are identical, irrespective of which mineral is used. Many experiments have been made, using the calcined material alone, or mixed with ball clay, or ball clay and feldspar, or calcined alumina. Mixtures of calcined and raw cyanite were used with 5% ball clay added. The addition of feldspar gave a vitrified product, though the refractoriness was above cone 28, even with 10 parts feldspar in 115. A mixture of 76.1% calcined cyanite with 23.9% alumina (calcined at 1650°C) gave brick which showed practically no shrinkage and were of good texture. E.J.V.

Fireclay compositions. P. REHAUS. *Refrac. Jour.*, **5** [59], 424 (1930).—Fireclay bodies, slips, and glazes are described and discussed. Their compositions are outlined. See also *Ceram. Abs.*, **9** [2], 111 (1930). E.P.R.

Jointing cements. CYRIL EDWARDS. *Trans. Ceram. Soc.* [Eng.], **28** [10], 405–13 (1929); for abstract see *Ceram. Abs.*, **8** [12], 888 (1929). R.F.S.

Effect of nonplastics (grog) on shrinkage and porosity of fire clay in the unfired state. S. R. HIND. *Trans. Ceram. Soc.* [Eng.], **29** [1], 10–29 (1930).—It is found that the essential relationships are dependent on the relative volumes of clay, grog, and water present in the body. Linear measurements of contraction, carried out in the usual way, are useless for systematic study and may lead to error in practical application. The ultimate (dry) porosity of a plastic clay made up to varying initial consistencies is not affected seriously by such variation. Decrease in the size of grog in 30% mixtures was found to increase the ultimate porosity slightly and the amount of tempering water to a more serious extent. The increase in tempering water was found to be consistent with the postulate that the volume of additional water was proportional to the square root of

the surface factor. The ultimate (dry) porosity of mixtures with a porous and with a nonporous grog throughout the whole range of possible mixtures was investigated. With nonporous grog, the porosity decreased in a linear manner with increasing grog-content up to 60%, after which it increased up to that given by the packing density of the dry grog alone. The same critical point occurred at 60% grog with porous grog, but the decrease in porosity was slight. The increase after this point was greater than in the case of nonporous grog. The porosities with both types of grog in proportions of 60% and over were approximately proportional to the percentage of grog present and determined by the packing-density of the pure grog. The apparent specific gravities of the same mixtures reflected the same features but less definitely. A new method of plotting contraction data is shown. From the graph, the linear contraction for any percentage of grog and initial consistency may be read off directly. The decreasing tempering water required with higher proportions of grog obscures the fact that contraction increases with grog content if the percentage of tempering water is maintained constant. The volume-contraction of mixtures of ordinary working consistency was found to be proportional to the percentage of clay present. Data indicate that there is no systematic difference in this respect between mixtures made with wet or with dry grog. The shrinkage-drying curves were examined in detail and show that the presence of grog arrests the contraction of the clay at an earlier point, giving an increased porosity between the grog particles, even though the porosity of the mixture as a whole may show a decrease. A moderate allowance of time for maturing, followed by remixing, assures that porous grog becomes substantially saturated. The clay particles do not penetrate into the pores of a porous grog and mixtures containing porous grog will take appreciably longer to dry than where nonporous grog is used. The drying of pieces made with porous grog will be safer, on account of lower moisture-gradients consequent on the earlier penetration of air into the water. R.F.S.

Preparing a silicate bonding mortar. ANON. *Brick Clay Rec.*, **77** [4], 216 (1930); reprinted from *Silicate P's & Q's.*—While it is true that silicate of soda, in common with most soda compounds, has a tendency to lower the melting point of refractories it is not impossible to prepare a silicate bonding mortar by judicious choice and blending of refractory materials in such a way that the joint will withstand the same service conditions as the brick. The use of silicate has the great advantage of making a strong air set possible so that the finished work, regardless of the temperature to which it is exposed within the limits of the manufacturer's recommendations, has the important feature of mechanical strength. E.J.V.

Special refractories. ANON. *Refrac. Jour.*, **5** [59], 424 (1930); for abstract see *Ceram. Abs.*, **9** [10], 848 (1930). E.P.R.

Ceramic glass studies. I. The ceramic glass properties of silicic acid. OSCAR KNAPP. *Glashütte*, **58** [49], 907–908 (1928).—In the glass industry silica plays a double rôle: (1) as a constituent of the glass and (2) as a constituent of the refractory used in melting the glass. The properties of the silica which is used for the latter purpose are designated by the term "ceramic glass properties." Silica occurs as a constituent of most rocks. In clays it forms the most important constituent as an aluminium silicate, $Al_2O_3 \cdot 2SiO_2$. Chemically it is highly resistant; it is not attacked by acids except HF and the phosphoric acids. For ceramic glass purposes, however, the physical properties are as important as the chemical properties. *E.g.*, the coefficient of expansion of a ceramic glass material determines its resistance to temperature changes, and the smaller this coefficient the more resistant it is to such changes. Of all the forms in which silica may occur, this coefficient of SiO_2-glass has the lowest value. That of the various crystalline modifications is about three times as great. The specific gravity and the heat conductivity are other important properties which vary for the different modifica-

tions. The fact that silica may be heated practically to its melting point before it softens appreciably is another important property which determines its use as a ceramic glass material. **II. Salts of silicic acid.** *Ibid.*, **59** [8], 125–27 (1929).—An investigation of the system Al_2O_3–SiO_2 showed the formation of one compound, sillimanite, of the composition $Al_2O_3 \cdot SiO_2$ which melts at 1816°C. The eutectic of sillimanite with silica melts at 1610°C, while that of sillimanite with alumina melts at 1810°C. According to the investigation of Eitel of the Kaiser Wilhelm Institute, Berlin, the compound mullite does not exist. The crystals, which Bowen and Greig claim are mullite, are composed of finely crystalline sillimanite, in which is embedded very finely crystalline corundum, and a high-silica glass. Even though mullite is no compound, this composition is more important in ceramic industries than sillimanite since it only begins to melt at 1810°C. Its use is highly recommended as a refractory. There are two other groups of silicate salts which are important in ceramics, feldspars and iron silicates. L.T.B.

Hot patching. H. PARDOE. *Trans. Ceram. Soc.* [Eng.], **29** [4], 87–92 (1930).—Bottle-tightness of retorts, whether in the gas, zinc, or similar industries, can only be assured if some method of tightening up is possible at a stage when thermal expansion has given a permanent "set" to the refractory construction, *i.e.*, when the temperature of the plant is raised to working heats. "Cold patching" does not meet the case, as the leaks are brought about entirely by thermal expansion operating on refractory walls. The problem is one of daily occurrence in many industries, particularly those in which the muffle principle is in use, and gas-tightness of the refractory dividing walls is an essential to efficient production. Periodical spraying of refractory walls definitely gives longer life to the construction by retarding erosion. A highly refractory material working at a moderate temperature becomes hard on the face when treated with a wash of suitable material; such hardening does not penetrate into the brick to any appreciable extent, but forms a case-hardening effect, which renders the surfaces almost immune from erosion. A spraying machine combined with air pressure was experimented on. In paddle or peel patching, a quantity of plastic material is manipulated on the end of a 16-ft. peel in horizontal retorts, etc., but it is very difficult to patch successfully a vertical chamber either from top or bottom at any distance from the openings. To attempt to patch silica with a peel at anything like working heats is futile. The air-gun method can be used successfully, but the detonator guns promise to give the most serviceable results. The one experimented with has a definite firing device and the result is a light but robust arrangement of action and cartridge extractor outside the retorts, while the barrel, with its easily adjusted lengthening pieces, is connected with the slurry holder. The pressure in the barrel created by firing the blank cartridge instantly builds up, as the volume is limited to the space between the breechblock and bursting diaphragm, until the resistance of the latter is overcome and the contents of the slurry holder are projected onto the objective at a high velocity, sufficient to penetrate into the joints to the full depth of the brick. With the addition of spare nozzle pieces and slurry holders, it is possible to fire two or three shots per minute and always on the target. Experiments were made on various mixtures of hot-patching material to meet the various conditions and the following was found to be the best: fine silica sand (200-mesh) 3 parts; precalcined bauxite grog (10-mesh) 2 parts; powdered plate glass (100-mesh) 3 parts; powdered vegetable glue 2 parts; lime, $1^1/_2$ parts. See also *Ceram. Abs.*, **9** [6], 435 (1930). R.F.S.

Open-hearth operators discuss steel-making problems. ANON. *Iron Age*, **125** [22], 1601–1604 (1930).—Furnace construction, operation, fuel, refractories, organization, control instruments, pouring practice, and heat treatment were discussed at the 11th semi-annual meeting of the Open-Hearth Comm. of the A.I.M.M.E., in Buffalo. The use of Loftus brick was reported by the chairman of the refractory committee to have

given 336 heats of the first run of the furnace, which had minor repairs after 180 heats. At the time of the minor repairs there was a deposit of about 3 in. of soot on the top row of the air checkers, and perhaps $^1/_2$ in. about 6 courses down. At the conclusion of the entire run the gas checkers were found slagged down badly, resulting in a recovery of only about 50% of the brick against 90% from the air checkers. Keeping a furnace hot to burn in a bottom, through melting the finely-crushed slag and then cooling it off before charging was recommended. The cooling was desired so that the bottom would not be plastic at the time the heavy material was put in. If silica in the bottom gets above 5% there is likely to be trouble from the bottom holes. An analysis is made of the slag being used, and it is mixed with the magnesite in the proportion of 1:5 or so, according to the silica found in it. This may run as high as 16%. At the end of the bottom making, the proportion might be as great as 10 of magnesite to 1 of slag. American magnesite was found to give as good results as imported. California and Washington magnesite was not compared. Refractories in service should be more or less plastic instead of rigid. Rigidity is needed, however, in the parts which are made of silica brick. According to one authority it is not advisable to use 20% of slag in the magnesite mixture for the bottom. It is used, however, because it is needed to make a bond on account of the slow coalescence of the magnesite. Dolomite has quick coalescence, but it lacks the degree of permanence possessed by magnesite. An effort is being made to develop a quick-setting magnesite. E.C.C.

γ-alumina and spinels. W. Biltz, A. Lemke, and K. Meisel. *Sprechsaal*, **63** [30], 564 (1930); for abstract see *Ceram. Abs.*, **9** [7], 579 (1930). M.V.K.

Manufacture of refractory products in U.S. G. V. Evers. *Jour. Soc. Glass Tech.*, **14** [54], 205–18 (1930).—These impressions were gained during a 15-day trip through some refractory plants in the U.S. The factors which tend to assist the efficiency of these plants are (1) large demand making mass production on a larger range of patterns than in England; (2) coöperation, a number of factories being in close union of management; (3) standardization of shapes and sizes has proceeded further than in England. A brief description is given of the shaping, repressing, drying, and firing of fire brick used in iron and steel works. The excellent finish, sharp edges and corners, and cheapness with which this was done with the high price of the finished article made a good impression. A common-brick plant in the New York district is described. The firebrick plants in St. Louis district are characterized as comparatively modern, well-laid out, clean, and efficient. A typical lay-out is described in detail. Firing is in a transitional stage, and from a fuel economy point of view varies from very bad to very good. The tunnel kilns, particularly of the Harrop type, are used as a basis of comparison with the practice of firing in England. The occurrence, composition, and use of diaspore are discussed. Standard of quality, regarding shape, size, and soundness of this product is very high. Attention is given to scientific control and research in the industry. At a magnesite brick plant a well-equipped laboratory and research department made a good impression. It was a matter of surprise that many large firms send their problems to Mellon Institute or other research centers and have few plant laboratories to carry out routine work. Two interesting apparatus in silica brickmaking are the Davis machine and a tunnel kiln. Glass pots are made in much the same way as in England. In ultimate quality, E. thinks the English have the advantage in blocks. Silica brickmaking is described in considerable detail. Discussions and questions by various English ceramists are also given. G.R.S.

Heat transfer in regenerative systems. III. George V. Slottman. *Blast Fur. Steel Plant*, **18** [9], 1469–70 (1930).—S. discusses the practical application of the formulas developed in his previous articles to the design of regenerators. Illustrated. See also *Ceram. Abs.*, **9** [7], 567 (1930). E.J.V.

Methods of testing for foundry molding sands. J. G. SKERL AND W. J. REES. *Refrac. Jour.*, **5** [59], 402 (1930).—The British Cast Iron Research Assn. has issued Report No. 73. For daily foundry control of molding sand the Assn. recommends two simple tests, (1) compression strength and (2) permeability, and has devised two pieces of apparatus whereby these may be measured. The absolute necessity of standardizing foundry sand testing in Great Britain is made evident. The U.S. has had standard methods for some years. The tests described are (1) moisture content, (2) mechanical analysis, (3) strength (green and dry sand), (4) permeability, (5) expansion and contraction, (6) refractoriness, and (7) chemical analysis. E.P.R.

Silica hearth of a copper-refining furnace. OTTO WINTER. *Metallbörse*, **20**, 761–62 (1930).—Practical directions for making and using SiO_2 hearths. (*C.A.*)

Study checker brick in glass tank application. ANON. *Ceram. Ind.*, **15** [3], 292–93 (1930).—R. M. King is conducting a study on open-hearth and glass-tank checker brick at Ohio State Univ. An effort is being made to correlate the life of a checker brick with its fundamental properties, process of manufacture, and region from which the raw materials come. A summary and discussion of data obtained so far is presented. W.W.M.

Hastening of silvering of glass by the use of $SnCl_2$. H. V. WARTENBERG. *Z. anorg. allgem. Chem.*, **190** [1], 185–87 (1930).—Glass may be silver plated more readily if treated preliminarily with $SnCl_2$ solution. The action is not a permutite exchange because similar treatment of quartz glass causes an increase in the rapidity of the plating operation. It is not due to the reducing action of $SnCl_2$, but to the fact that the $SnCl_2$ solution acts only as a simple SnO_2 sol, which sol is absorbed on pickling. This absorbed sol hastens the separation and precipitation of the silver. Other colloidal solutions were found to act similarly although not so well. Gold plating of glass can be hastened by treatment with $SnCl_2$. L.T.B.

Refractories. ANON. *Times Trade Supp.*, p. 31 (July, 1930); *Refrac. Jour.*, **5** [59], 424 (1930).—Lapidary enamel produced in all colors is now on exhibition at Liége. It offers complete resistance to all changes of temperature, is slightly translucent, has considerable hardness, and a perfect polish. The resistance to wear is midway between that of basalt and porphyry. E.P.R.

Dry-pressing methods. ANON. *Brick Clay Rec.*, **77** [4], 211 (1930); *Clay-Worker*, **94** [2], 98–99 (1930).—The Dry Press Committee of the Ohio Ceramic Industries Assn. met in Columbus, Ohio, July, 1930, to present to the manufacturers of refractories and to manufacturers of presses data obtained at the Roseville Experiment Station, which appear to indicate that refractories formed under higher pressures than those now employed have many desirable properties. In these experiments, brick were made up on several plants at the pressures normally employed and at Roseville at pressures varying from 1000 to 6000 lbs. per sq. in. Physical tests including the normal purchase specification tests were run on the ware. The conclusions are enumerated. E.J.V.

Microstructure of some west of England siliceous brick. J. M. COON. *Trans. Ceram. Soc.* [Eng.], **29** [4], 125–37 (1930).—The brick were made from mixtures of material derived from the kaolinization or decomposition of granite or granitic dykes therein. The manufacturing process is practically identical at all the works: The material is fed to the pugging mill by an attendant who relies on judgment and experience for the quantities mixed. The plastic material is delivered to tables, forced into sanded molds, wire cut on top, placed on drying floor, and when sufficiently dry these still plastic lumps are shaped in foot-driven presses and again placed on the drying floor until in suitable condition for setting in kiln. Round downdraft kilns are universally employed for firing, which takes approximately 13 days, *i.e.*, 3 days steaming or drying, 4 to 5 days firing, and 5 to 6 days cooling. The firing is controlled by test pieces, this being

found most convenient on account of the variation in raw material. The heat employed approximates Watkins' No. 31 or cones 10 to 12, at about 1300°C as maximum. The difference in temperature from top to bottom of setting must be considerable. The chief interest in respect to microstructure focuses on (1) alteration of silica as quartz through tridymite to cristobalite, the latter stage being only recognizable ambiguously and infrequently, (2) formation of sillimanite or mullite through gradual solution of silica in the glassy melt of the aluminous bonding material, (3) slag formation on exposed faces, and (4) invasion of adjacent body of brick with magnetite and cristobalite in slag. R.F.S.

How large crucibles are made. RALPH BROWNE. *Iron Age*, **126** [6], 349–50 (1930).—The Bartley Crucible Refractories Co. produces the largest graphite crucibles in the world. They are made to hold 4000 lbs. of zinc. Careful aging, molding, drying, and firing are the outstanding features of this plant. E.C.C.

Aluminous refractory materials: cyanite, sillimanite, and corundum in northern India. J. A. DUNN. *Mining Jour.*, **167** [4915], 876 (1929); for abstract see *Ceram. Abs.*, **9** [3], 201 (1930). E.C.C.

Chromite in 1929. ANON. *Blast Fur. Steel Plant*, **18** [9], 1460 (1930).—Commercial shipments of domestic chromite in 1929 totaled 180 long T. valued at $3226, compared with 660 T. valued at $14,807, in 1928. These shipments in 1929 were from Calif. The imports of chromite into the U.S. in 1929 established a new record and amounted to 317,630 long T. E.J.V.

Refractory researches in Ontario. R. J. MONTGOMERY. *Rept. Ontario Dept. Mines*, 1930; *Refrac. Jour.*, **5** [59], 424 (1930).—The results of research work carried out on a semi-industrial scale are described, together with a general survey of the industry in Ontario. E.P.R.

Statistics from the refractory industries of Great Britain. Compiled from the STATISTICAL DEPT., ENG. BOARD OF TRADE. *Feuerfest*, **6** [7], 104–106 (1930).—This report relates to the production, use, price-fixing, and exports of the refractory industries of Great Britain and her colonies. L.T.B.

Russia. The silica industries. CARL PETERS. *Feuerfest*, **6** [7], 106 (1930).—Production figures of the larger silica brick plants in Russia are reviewed. L.T.B.

BOOK

Testing Laboratory for Refractories. (Prüfanstalt für feuerfeste Materialien.) L. LITINSKY. 127 pp., 83 illus. Otto Spamer, Leipzig, 1930. 8.5 M. *Feuerfest*, **6** [7], 110 (1930).—A comprehensive report is given on the activities in all countries in the field of the study and testing of refractory materials. It is especially valuable in the selection of apparatus for a laboratory and this field is well covered in the book. See also *Ceram. Abs.*, **9** [7], 551 (1930). L.T.B.

PATENTS

Furnace wall. JAMES C. HOBBS. U. S. 1,772,486, Aug. 12, 1930. In a furnace, a wall made in sections spaced apart, both sections being made of material of low heat conductivity, members of good heat-conducting material as compared to the material of the sections placed in the inside section with their inner edges spaced from the inside face of the section and their other edges extending into the space between the sections.

Fireproof arch. CHARLES H. BUTZ. U. S. 1,772,797, Aug. 12, 1930. An arch construction comprising, in combination, a plurality of spaced, transversely extending beams, each formed from two beams having adjacent vertical surfaces spaced apart to form a slot for the reception of supporting bolts, a plurality of spaced, parallel beams located underneath the first-mentioned beams, each of the lower beams being formed

from two beams spaced apart to form a slot, a plate extending across the under side of each lower beam directly beneath the point where it crosses the upper beam, the plate having an opening at each side of the lower beam, a bolt extending through each opening and upwardly through the slot in the upper beam, means for putting the bolts under tension for the purpose of securing the beams together, a plurality of supporting rods extending through the slot in each of the lower beams, the lower end of each rod being bent at an angle so as to form a supporting hook and a refractory block secured to each hook, each block having an opening for the reception of the hook.

Furnace wall. LEE M. BEALL. U. S. 1,773,339, Aug. 19, 1930. In furnace wall construction, an outer wall, an inner wall, horizontal vertically-spaced supports on the outer wall, superimposed brackets mounted on lower supports and anchored to upper supports and carrying the inner wall in spaced relation to the outer wall, and means for locking the inner wall to the supports.

Making furnace roofs. GLENN E. HILLIARD. U. S. 1,773,359, Aug. 19, 1930. The method which comprises assembling brick to form a furnace-arch section, maintaining the brick in assembled relation by clamping means disposed within the end boundaries of the section, supporting the section upon a templet which is of less length than the section but of greater width than the section, moving the templet and the section supported thereby into position above furnace walls and bringing the ends of the section into seating engagement with the walls, and releasing the templet.

Wall structure. CARL THOMAS CARLSON. U. S. 1,773,516, Aug. 19, 1930. In a wall structure, the combination of an inner wall formed of refractory brick comprising cross-brick projecting from the outer face of the inner wall, the cross-brick having a projecting lip on its projecting end; an outer wall of brick spaced apart from the inner wall and having inserted in its courses a metal plate projecting from the inner face of the outer wall and having a hooked end engaging the lip of the cross-brick, the brick of the immediate courses below the plate being stepped inwardly from the inner face of the inner wall under the plate.

Refractory furnace wall. ARTHUR F. HALL. U. S. 1,773,729, Aug. 26, 1930. A refractory furnace wall comprising inner and outer sections, and a plurality of spacer bars extending across the air space between the sections, having detachable interlocking engagement at each end with the sections and being accessible from outside the wall.

Pyrometer tube. FRANK C. SIMMS. U. S. 1,773,825, Aug. 26, 1930. As a new article of manufacture, a fired unitary refractory composite pyrometer tube structure comprising an inner tube of refractory material and an outer heat-equalizing tube of refractory ceramic material therearound and intimately bonded thereto by firing.

Pyrometer tube. FRANK C. SIMMS. U. S. 1,773,826, Aug. 26, 1930. As a new article of manufacture, a unitary laminated pyrometer tube structure comprising an inner highly refractory gas-tight tube of ceramic material, an intermediate tube of a refractory material constituting a heat shield for the inner tube, and an outer tube of a slag and fume resistant refractory material, all of the tubes being intimately bonded with each other by firing the outer tubes and the inner tube as a unit.

Mud gun. JOHN C. HOPKINS. U. S. 1,774,373, Aug. 26, 1930. The combination with a blast-furnace, of a clay-gun mechanism comprising a swinging carrier, a clay gun mounted on the carrier, a coupling member on the carriage, a coöperating coupling member on the furnace, the coupling members being adapted to be automatically locked together when the carriage is moved toward the furnace to lock the carriage against reverse position.

Bonding refractories. SIMON J. LUBOWSKY. U. S. 1,774,607, Sept. 2, 1930. The method of bonding refractories comprises admixing such as refractory with a finely-divided rutile and bonding the mixture at a temperature sufficient to sinter the rutile and

convert it into a hard, homogeneous, coherent product containing the admixed refractory.

Furnace lining. GEORGE DAVID EVANS. U. S. 1,775,161, Sept. 9, 1930. A furnace lining comprising a magnesite brick impregnated with a matrix of oxides of copper and absorbed silica, the matrix having silica particles embedded therein.

Refractory brick. ARTHUR J. JACKMAN AND CHARLES L. JONES. U. S. 1,775,396, Sept. 9, 1930. A composite brick comprising a body of relatively poor heat-conducting refractory material having embedded therein a rod of relatively good heat-conducting nonmetallic refractory material extending in a direction generally normal to the face of the brick which is to be exposed to furnace heat.

Furnace-wall structure. FRANK J. TONE. U. S. 1,775,414, Sept. 9, 1930. In a furnace wall, a water-circulating conduit and a protective nonmetallic refractory coating thereover, the refractory coating comprising silicon carbide having a thermal conductivity in excess of 0.006 cal./cm.^{2}/°C sec.

Furnace roofs. A. REPPMAN. Brit. 330,326, July 30, 1930. In roofs for furnaces and combustion chambers, brick are suspended between supporting-members in groups of three, the two outer brick of each group having inclined surfaces engaging the supports, while the third brick acts as a keystone. The supports may be of wedge, cylindrical, or fishtail form, and the outer brick may be of identical size so that their outer faces come vertically beneath the supports.

Preparation of alumina. W. J. MULLER AND H. HILLER. Brit. 330,661, Aug. 7, 1930. Bauxite is treated with aluminate lye of 20 to 22° Bé at temperatures above 190°C, and at a pressure corresponding to the vapor pressure at this temperature. The mixture of alumina lye and bauxite may be kept in a continuously progressive movement through the decomposition autoclave by means of a high-pressure pump, and allowed to issue from the reaction chamber through a loaded valve or through a corresponding counter-pressure pump. The red slime is separated from the reaction mixture and the aluminium hydrate caused to separate in a manner known per se. *E.g.*, using a bauxite from Salzburg, 96% of the alumina present goes into solution when treated at 200° with a lye of 20° Bé, using a Hungarian bauxite, 62% goes into solution when treated with a 22° Bé lye at 230° and an excess pressure of 25 atmospheres, and 93% when treated at a temperature of 280 to 290° and at about 100 atmospheres pressure. In this process no concentration of the aluminate lye is required at any period (except the concentration by evaporation of the wash liquors to 22° Bé).

Refractory substances. W. MCBRYDE. Brit. 330,745, Aug. 7, 1930. The carbon in carbonized clays, which have been produced by the process of Specification 149,440, is removed by oxidation. Preferably the oxidation is effected during or immediately after the production of refractory units by introducing preheated air into the firing kiln.

Fused silica. W. C. HERAEUS GES. AND A. KRÖNER. Brit. 330,943, Aug. 13, 1930. A process for the preparation of hollow bodies from refractory material, such as quartz, consists in melting or sintering the material in a rotating hollow mold by a source of heat situated within the mold, the material being held in place against the wall of the mold by centrifugal force. The mold is rotated about its longitudinal axis by means of rollers on which it is supported. A source of heat, such as an electric arc between electrodes is arranged within the mold and is movable along its longitudinal axis. Granulated or powdered material (broken rock crystal or sand), is charged into the mold and forms a layer around the wall. Soon after the introduction of the arc, a tube is formed of the fritted or molten material which remains separated from the mold by a layer of unmelted material and increases in length as the arc is moved along the axis of the mold. The walls of the mold may be formed with depressions which produce on the finished tube protuberances that can be removed and shaped into bowls or crucibles. Silica tubes,

prepared by any suitable process, can be reheated in the mold and shaped in bowls, etc., by centrifugal force. Oxidizing or reducing gases may be introduced into the mold if required. Specification 10930/10 is referred to.

Refractories for metallurgical furnaces. BERK. Fr. 675,238; *Refrac. Jour.*, **5** [59], 424 (1930).—A refractory lining for use in furnaces for refining metals in the presence of alkalis consists of intimate mixtures of ganister and 5 to 25% of carbon. E.P.R.

Treating bauxites. URBAIN V. VOISIN. Fr. 679,802, Dec. 19, 1928. To eliminate SiO_2 in the form of SiF_4, bauxite is mixed with CaF_2 and heated with H_2SO_4. The sulphates are precipitated with lime or they are calcined to obtain Al_2O_3 and Fe_2O_3. (*C.A.*)

Refractory materials. METALLGES. A.-G. Fr. 682,249, Sept. 24, 1929. Refractory materials of Mg silicates, particularly natural silicates, as olivine and serpentine, are made by mixing silicates which expand on heating, as olivine with silicates which contract on heating, and as serpentine. Other substances as MgO or magnesite may also be added. The silicate which expands is used in larger grains than the one which contracts. (*C.A.*)

Terra Cotta

Development in spraying devices. R. F. GRADY, JR. *Jour. Amer. Ceram. Soc.*, **13** [10], 780–86 (1930); for abstract see *Ceram. Abs.*, **9** [3], 204 (1930).

Methods of fixing roofing tile and their influence on tile lamination. LESLIE G. TOMLINSON. *Trans. Ceram. Soc.* [Eng.], **29** [1], 1–9 (1930); for abstract see *Ceram. Abs.*, **9** [1], 49 (1930). R.F.S.

Wall units of terra cotta. ANON. *Architect*, **14** [3], 322 (1930).—A new type of terra cotta in standard sizes 16 by 8 in. is used in interior decoration. G.R.S.

Terra cotta skyscrapers. ANON. *Pottery Gaz.*, **55** [639], 1405 (1930).—Some American skyscrapers being constructed with colored terra cotta for exterior surfaces are discussed. An illustration of the Chanin Building in New York, of buff brick and terra cotta construction, is included. E.J.V.

New Era. ANON. *Die Form*, pp. 302–304 (June, 1930).—The New Era is the name of an international exhibition in Cologne, 1933, which will aim to show the organic result of the developments of a century conspicuous for its discoveries, inventions, and transformations of form. Nations will coöperate in an exhibit of seven groups: (1) vision of the universe; (2) development of man; (3) control of power and material; (4) building and housing; (5) city and regional planning; (6) building-up of the state; and (7) the world. (*D.I.*)

New birth of Colonial Art. ROBERT W. DE FOREST. *Nation's Business*, pp. 25–27 (June, 1930).—The American public is rediscovering its own artistic origins and in so doing is vastly improving the national taste. (*D.I.*)

Every age creates its own modern architecture. W. K. OLTAR-JEVSKY. *Amer. Architect*, pp. 28–30 (July, 1930).—Building materials, methods of construction, and social conditions are the elements that create and define a style. (*D.I.*)

The cactus—a modern motif. MARIAN MACLEAN FINNEY. *Western Advertising*, pp. 44–45 (June, 1930).—Cactus is being used in sculpture, in tile for friezes and patio walks, for fountain trim, and garden pools. (*D.I.*)

BOOKS

Examples of Modern French Architecture. Edited by HOWARD ROBERTSON AND F. R. YERBURY. Ernst Benn, Ltd., London, 1928. About $10.00. 100 photos. (*D.I.*)

Le Corbusier et L'Architecture Contemporaine. S. GIEDION. *Cahiers D'Art*, No. 4 (1930). $1.00. A review of modern architecture revolving around the ideas and achievements of its great French proponent, Corbusier, is presented. (*D.I.*)

Die Baukunst der Neusten Zeit. GUSTAV ADOLF PLATZ. Propylaën-Verlag, 1930. About $12.00. Four hundred illustrations follow an explanatory text on the architecture of modern times. The list of architects represented, with short biographical notes, is an interesting directory of men prominent in European architecture. (*D.I.*)

White Wares

Casting of clay wares—a résumé. F. P. HALL. *Jour. Amer. Ceram. Soc.*, **13** [10], 751–66 (1930).—Considerable difficulty has been encountered in developing methods suitable for determining the properties of a casting slip that in turn define the casting quality of the slip. A survey of the literature is made, especially that dealing with the colloidal phenomena of clay suspensions, which might be of assistance in solving some of the problems encountered in the use of the casting process. The term casting quality of slip is defined and the factors which influence this property are considered in detail. Control methods proposed by various investigators are discussed critically. A new method of slip control is suggested. The sources and remedies of some troubles encountered in the casting process are discussed.

Prevention of brown stains on semivitreous tableware. G. A. LOOMIS. O. S. U. Eng., *Expt. Sta. News*, June, 1930; *Ceram. Ind.*, **15** [2], 171 (1930).—Some potteries making semivitreous tableware were troubled with brown stains on ware which was bedded in sand during the bisque firing. The sand contained a small percentage of black grains of iron-bearing mineral, but did not always stain ware fired in it. On investigation it was found that with neutral or reducing atmosphere the stains were present, but with oxidizing conditions they were absent. The difficulty was overcome by cutting holes in the saggers to allow circulation and increasing the excess air in the kiln, or by preheating the green ware to oxidize it before firing so that it would not reduce the iron in contact with it. W.W.M.

Special electromagnetic separators and application to the general pottery trade. W. E. BOX. *Trans. Ceram. Soc.* [Eng.], **28** [12], 447–56 (1929).—In the manufacture of fire brick, iron particles due to the difference in contraction at high temperatures produce cracks during the firing process. The presence of iron in insulators reduces the dielectric strength to some degree. Practically all of the black specks in finished ware are really particles of iron, whereas the dark brown and yellow specks are pyrites. The chief sources of black specks are nuts, bolts, wire, nails, etc., which inadvertently find their way into the ware during handling and preparation. Other iron in various forms finds its way into material due to overhead machinery, iron settling tanks, etc. Rapid strides have been made in the design and manufacture of magnets since the early day permanent magnets. At present, magnetic separators are available in various sizes and types for dealing with all classes of wet and dry material and capable of extracting practically all high and feebly magnetic iron specks other than those in such a subdivided state as not to be detected by the naked eye. The main advantages to be obtained by the installation of suitable separators are clean unspeckled ware and in the case of insulators and firebrick manufacture, better quality goods. Grinders, by extracting "tramp" iron, not only prevent the major portion of trouble to the potter but also save costly stoppages due to jams in the handling at the plant. The type "CC" magnetic separator is discussed for treating wet material, type "C" being the more efficient. Applications of magnetic separators to dry material such as bone, flint, ball clay, frit, etc., are discussed. R.F.S.

Gypsum molding plasters. ANON. *Rev. mat. constr. trav. pub.*, No. 238, pp. 262–63 (1929); *Rock Prod.*, **32** [26], 97–98 (1929).—A study of gypsum plasters shows that the good molding plaster is a semihydrate, contains no unfired, overfired, or foreign matter, and is uniform. Between plasters there is only the difference in fineness of grinding. There is but one quality of molding plaster; it is mixed with about 65% water, has a working period of 10 to 15 minutes and reaches a strength of 284 to 313 lbs./sq. in. in dry specimen brick. The properties desired in the molding plaster by the various trades include primarily a high strength, sufficient porosity, and a good yield. When less water is used in the mix the strength increases, but the porosity and yield decrease, and vice versa when more water is used. For a plaster of higher strength a smaller quantity of water has to be used. A plaster has been developed which requires normally only 45% of water by weight and gives a tensile strength double that of ordinary molding plasters. In certain special cases only 35% of water need be used, which gives a paste of the consistency of glazier's putty; this is then pressed into the mold; its tensile strength is $2^1/_2$ times that of ordinary plasters. The yield and porosity factor decrease considerably, the mass becoming very dense so that it is well protected against the solvent action of water. Mixed with 45% of water, the plaster is suitable for all work requiring a high strength and where yield and porosity are less important, as in foundry work. When mixed with 65% water this plaster gives strength, yield, and porosity of ordinary molding plaster. W.W.M.

Commercial feldspar. FRANK P. KNIGHT, JR. *Ceram. Ind.*, **15** [3], 296–98 (1930).—K. states that the term "feldspar," as used in ceramics, is a misnomer; it is a mixture of feldspars plus some contaminating materials. He stresses the irregularities of feldspar deposits and cites several authorities on this subject. Eight samples of feldspar ore are described. The method of obtaining a uniform product is discussed, with special emphasis on chemical control. This method will continue to be the chief factor in maintaining uniformity of commercial feldspar. W.W.M.

"Steatite" (talc). ANON. *Ind. Chemist* [London], **6** [65], 233–37 (1930).—The raw material and its treatment, insulators made therefrom, and their testing are described. (*S.S.*)

Electric conductivity of ceramic insulating materials at increased temperatures. FELIX SINGER. *Keram. Rund.*, **37**, 236 (1929).—The electrical conductivity of fine ceramic insulators is measured at temperatures from 100 to 400°, using as test pieces tubes 15 cm. long, 4 cm. in diameter, and 0.4 cm. wall thickness. The conductivity increases rapidly and nearly linearly. The results are plotted and compared with those of other workers for glass, porcelain, and quartz. H.I.

New insulating product. ANON. *Ceram. Ind.*, **15** [2], 198–99 (1930).—The Carey research organization, the Mellon Institute, and the Aluminum Company of America have coöperated in the development of "Carey Aluminite," a commercial high temperature heat-insulating material derived from bauxite. The Phillip Carey Mfg. Co. will erect a half-million dollar plant for the production of insulating block, brick, and powder. The blocks will be $2^1/_2$ x 9 x 36 inches in size, or equivalent to eight standard brick. The Aluminite insulation is designed for use in electric furnaces, with firebrick boiler settings, in glass furnaces, regenerators, etc., where temperatures range from 1800 to 2600°F. A $2^1/_2$-inch thick layer of this insulation on a glass furnace raised the previous external wall temperature to 1500°F from 800°F, while the temperature of the outside surface of the insulation was 150°F. Carey Aluminite weighs approximately 27 lbs. per cu. ft. W.W.M.

Comparing subsieve particle distribution in nonplastics. M. H. HUNT. *Rock Prod.*, **33** [17], 79 (1930); see also *Ceram. Abs.*, **9** [8], 654 (1930). W.W.M.

Dolomite earthenware. ANON. *Corriere ceram.*, **11** [7], 283 (1930).—Dolomite

earthenware is not widely known as it is produced only in South Germany and Switzerland. The paste is composed of one-third each of dolomite material, clay, and sand. It is fired at Seger cone 03 or 04 (1020 to 1040°C), contracting only slightly on firing which makes it well adapted for the manufacture of vases and receptacles. The preparation is given. M.V.K.

Use of modern volume production machinery in ceramics. F. LIPINSKI. *Keram. Rund.*, **38**, 131–32 (1930).—Some general considerations of the applicability of line-production machinery and methods to the various departments of a ceramic manufactory are given. H.I.

Technical advances in fine ceramics in 1929. W. STEGER. *Keram. Rund.*, **38**, 33–37, 54–56, 71–72 (1930).—A review is given of papers published in 1929 describing results of investigations of properties of ceramic materials and products, new methods of preparation and firing of ceramics, new compositions, and new methods of overcoming defects. H.I.

Plant improvements in pottery manufacture. GEORG LITTLEMAN. *Keram. Rund.*, **38**, 132–37 (1930).—Different types of conveyer systems are described and their applicability to the pottery industry is discussed. H.I.

Manufacture of floor tile. O. MÜCKER. *Keram. Rund.*, **38**, 103–107 (1930).—A description of the raw materials used, especially from German sources, and the effects of clays of different composition are given. H.I.

Buckling of floor tile. N. D. WOOD. *Trans. Ceram. Soc.* [Eng.], **29** [2], 63–83 (1930); for abstract see *Ceram. Abs.*, **9** [4], 293 (1930). R.F.S.

National tile survey. ANON. *Keramic Tile Jour.*, **2** [8], 40–41 (1930).—An analysis, with statistics, is given of business conditions all over the country. W.C.O.W.

Caustical tile. ANON. *Architect*, **14** [2], 216 (1930).—A new decorative artificial stone in colors, having the appearance of travertine, is put out by U. S. Gypsum Co. of Chicago. G.R.S.

Tiled bath in airplane. ANON. *Keramic Tile Jour.*, **2** [7], 39 (1930).—The J-5 Travelair owned by J. Rosenbaum of New York is equipped with a tile bathroom. W.C.O.W.

Attractive and practical method of displaying tile. ANON. *Keramic Tile Jour.*, **2** [7], 38 (1930).—The Robertson Art Tile Co. has devised a panelier for displaying tile, exhibited for the first time at the New Orleans convention. It is an attractive and practical method of overcoming difficulties in sales exhibits of tile. W.C.O.W.

Italian technical porcelain. ANON. *Pottery Gaz.*, **55** [639], 1429 (1930).—The production of technical porcelain, particularly insulators, has grown rapidly. Importation of porcelain insulators has fallen 50% in three years. E.J.V.

British pottery: Staffordshire ware. ANON. *Times Eng. Supp.*, **26** [620], 54 (1930).—The china industry centered in Stoke is slowly regaining its prosperity. The British Industries Fair is the "shop-window" of the china and tile manufacturer. Coal-fired kilns are gradually being replaced by gas- or electrically-heated kilns. H.H.S.

Development of the clay pot handle in prehistoric ceramics. K. H. WELS. *Keram. Rund.*, **38**, 59–61 (1930). H.I.

BOOKS

The Making and Burning of Glazed Ware. H. ANSELL AND A. B. SEARLE. *Ceram. Ind.*, **15** [2], 216 (1930); see also *Ceram. Abs.*, **9** [8], 689 (1930). W.W.M.

Porcelain Insulators and Insulating Porcelains. STEN VELANDER. *Z. Ver. deut. Ing.*, **74** [23], 772 (1930); for abstract see *Ceram. Abs.*, **9** [10], 858 (1930). L.T.B.

PATENTS

Insulator. KENT ALLEN HAWLEY. U. S. 1,772,513, Aug. 12, 1930. In com-

bination with a string of suspension insulators, a conductor clamp and a suspension link interposed between the lowermost insulator and the clamp, a splash-producing member located beneath the lowermost insulator unit and having an opening for the accommodation of the suspension link, and spaced attaching members at the top of the splash-producing member adapted to be connected with the suspension link.

Electric insulator. GOTTFRIED HOFFMANN. U. S. 1,772,947, Aug. 12, 1930. An insulator string having dumb-bell shaped members linking the insulating units of the string together, ring-shaped protective members, the opening thereof being of a diameter greater than that of the heads of the dumb-bell shaped members to permit passage of the heads therethrough annular flanges carried by the dumb-bell shaped members and disposed between the heads thereof, the peripheries of the flanges being adapted to contact with the peripheries of the openings of the protective members, and weld connections between the flanges and protective members.

Manufacture of teapot spouts, etc. WILLIAM COULTER. U. S. 1,773,447, Aug. 19, 1930. A press for the manufacture of teapot spouts, etc., comprising upper and lower intaglio dies or molds adapted to press a plastic clay or like body into a solid spout formation, and lateral coring dies adapted to be thrust into and out of engagement with one another, to core the solid body within the engaging upper and lower dies and render same of the desired hollow tubular formation.

Vitreous towel bar. EUSTACHIUS W. KOERING. U. S. 1,773,586, Aug. 19, 1930. A towel bar and support comprising a bar of vitreous material, a receptacle of vitreous material having a recess therein, means within the recess for securing the receptacle to a wall or other surface, and coöperating segmental threaded portions on the end of the bar and in the recess for securing the bar within the receptacle by rotative movement of the receptacle.

Protective device. HARRY A. EATHERTON. U. S. 1,774,874, Sept. 2, 1930. A protective device comprising in combination, an insulating receptacle having a central opening therethrough, a pair of metallic electrodes located in axial alignment within the opening with a space between their ends and means comprising a unitary solidified insulating member cast in place in the tubular opening for holding the electrodes in fixed relationship.

Spark plug. ROY T. HURLEY. U. S. 1,775,528, Sept. 9, 1930. In a spark plug, the combination of an insulator, a center electrode, a soft metal ferrule for effecting a sealing joint therebetween and cement surrounding the ferrule and the electrode.

High-tension electrical apparatus and insulating bushing therefor. GUSTAV E. JANSSON. U. S. 1,775,529, Sept. 9, 1930. The combination of an insulating bushing having an enclosing shell and a high-tension terminal therein, an insulated condenser plate disposed externally of and supported independently of the shell of the bushing and located within the field thereof, and an insulated terminal connected with the plate.

High-tension bushing having insulated supports. GUSTAV E. JANSSON. U. S. 1,775,530, Sept. 9, 1930. The combination of the casing of an electrical apparatus, a high-tension insulating bushing extended through the wall of the casing having an internal high-tension conductor and an externally disposed metal attaching collar supported by the casing, an insulating continuous disk interposed between the attaching collar and the casing and having a portion thereof spaced from the casing and collar and extended radially beyond the collar and providing a long creepage and strike-over path between the collar and casing, and insulated bolts connecting the collar and casing, the collar having a circuit terminal and constituting a condenser element of the bushing.

Supporting device for pottery. WALTER S. MAYER. U. S. 1,775,535, Sept. 9, 1930. A supporting device for pottery ware consisting of a transverse member having radially

disposed arms provided with radially disposed holding sockets, and a one-piece removable support thereon having ware-engaging projections.

Making porcelain articles; artificial teeth. A. S. WATTS. Brit. 330,397, July 30, 1930. Porcelain articles, *e.g.*, artificial teeth, are fired by first heating at gradually increasing temperature until vitrification occurs, then suddenly raising the temperature so as to provide a glazed coating by superficial fusion, and again abruptly lowering it to arrest the fusing action and finally cooling and annealing the glazed article. The process is carried out preferably in one kiln having zones of varying temperature through which the articles pass in succession.

Electric insulators. FELIX SINGER. Ger. 498,149, April 4, 1926. Addition to 493,001. Electric insulators prepared by the method of Ger. 493,001 (see *Ceram. Abs.*, **9** [8], 657 (1930)) are improved by known treatment such that the greater part of the Ti and Fe contents is at the higher stage of oxidation. (*C.A.*)

Equipment and Apparatus

Apparatus for determining degrees of fineness and some applications of this apparatus to various ceramic materials. S. BERG. *Trans. Ceram. Soc.* [Eng.], **28** [11], 427–35 (1929).—B. discusses sieving, wet elutriation, sedimentation, and a new sedimentation apparatus working according to the so-called pipette method. By the accuracy of results obtained and the rapidity with which they are produced, this apparatus has advantages over apparatus hitherto employed. It is not necessary to know the total amount of material being treated. This is particularly convenient when the material is in a wet state. R.F.S.

Automatic balancing and recording galvanometer. ANON. *Electrotech. Z.*, **51**, 430–31 (1930).—A lever mechanism, controlled by a moving-coil galvanometer, rotates a disk which carries a slide wire, the pointer of the registering instrument, and contacts for relays which can be made to control alarms or auxiliary circuits. The disk and lever mechanism are actuated by a shaft revolving at constant speed. The slide wire is used to maintain balance in any bridge circuit in which the galvanometer may be included. Among the many useful applications of the device is the control of chemical or physical processes where constancy of temperature or of concentration is required. Several illustrations and diagrams are given. M.A.B.

Mechanical stoking. H. PENNINGTON. *Trans. Ceram. Soc.* [Eng.], **28** [8], 381–86 (1929).—A survey is given of the mechanical inventions devised to meet difficulties experienced in the days of old egg-ended, underfired boilers. Mechanical stokers conserve the coal supply, produce conditions necessary for the most economical combustion of coal, prevent smoke, and save labor. It is necessary to use good fuels to obtain the required results. Efficient combustion, it is stated, requires either that the fuel be fed to the grate continuously, as in the chain grate, or that the feed be in small quantities at brief intervals of time. It is likewise essential that the incombustible residue of ashes and clinker be removed from the grate surface as it is formed. This must be done continuously and automatically, without disturbing the fuel bed or interfering with the air supply and distribution. The following measures are given to prevent smoke: (1) coal should be supplied in small quantities and at frequent intervals; (2) air supply should be slightly in excess of the theoretical requirements; (3) temperature of the furnace should be sufficiently high to ignite the gases; (4) the human element should be under technical control; (5) do not overload a boiler plant; give it a reasonable rating and do not expect it to run from 50 to 100% above rating; (6) keep the mechanical stokers under proper repair; each part, when working properly, assists

smokelessness. Another method which can be adopted to assist bad draft is the installation of an induced-draft fan. Manufacturers are urged to appreciate the value of a trained man to use their special apparatus. R.F.S.

Orifice meter. W. H. PARKER. *Gas Age-Rec.*, **66** [7], 236–37 (1930).—The orifice meter is velocity type, recording loss in pressure produced by forcing the fluid through an orifice of known area, static pressure of fluid, and time. The loss in pressure is the differential pressure across the orifice and is recorded in inches of water. The volume is readily determined from the recorded pressures and from the coefficient of the orifice. Early features of this meter and a comparison with other types are discussed. The meter is equipped with calibrating adjustments for both the differential and static pressures. These adjustments make accurate calibrating possible with a minimum of effort. While the volume range of any one orifice is limited, the range can be increased by installing two orifices and meters in parallel, controlling the flow through one or both by means of a quick-acting automatic valve controlled in turn by the differential pressure. Measurements with this meter can be obtained within less than $\pm 1\%$ variation when an accurate orifice is installed at a correct distance from sharp turns, valves, regulators, etc. Illustrated. E.J.V.

Adjustable orifice burner. ANON. *Blast Fur. Steel Plant*, **18** [9], 1491–92 (1930).—See preceding abstract. E.J.V.

Simple electrically controlled thermostat. JOHN ARNOLD CRANSTON. *Jour. Chem. Soc.*, 1458–60 (June, 1930).—Illustrated. E.C.C.

Precision measurement of liquid pressure. ANON. *Engineer*, **150** [3890], 116–17 (1930).—The simplest means for pressure measurement is that which depends on the height of a column of mercury supported by the pressure to be measured. This method may be considered as standard for pressures up to 40 or 50 lbs. per sq. in. For higher pressures deadweight testers are used. Various types of testers and their values are discussed. H.W.A.

Novel pyrometer. UEHLING INSTRUMENT CO. *Gas Age-Rec.*, **66** [10], 381 (1930); *Brick Clay Rec.*, **77** [6], 333 (1930).—An instrument for measuring and recording temperature, known as the "Self-Contact" potentiometer pyrometer, was designed for measuring high temperatures in the iron, steel, and ceramic industries. Either a thermocouple or an electric-resistance bulb may be used as the temperature element. This instrument eliminates the use of depressor bars, cam mechanisms, and continuously-operating motors. It retains all of the advantages of the potentiometer. The novel contact method permits placing the galvanometer apart and at almost any distance from the recorder. The recorder is actuated by a galvanometer, which will actuate as many as four recorders, each recorder in a different location, measuring a different temperature, and having a different calibration. Illustrated. E.J.V.

New types of sensitive silica manometers. B. LOCKSPEISER. *Jour. Sci. Instruments*, **7**, 145–51 (1930).—The manometers were designed for the measurement of vapor pressures of solids. Construction details and photographs are given. The Bourdon gage type is sensitive to 10^{-2} mm. Hg, and the diaphragm type to $^1/_6 \times 10^{-3}$ mm. Hg. (*C.A.*)

Measurement of puncturing strength of insulating oils in operation. F. FOERSTER. *Electrotech. Z.*, **51**, 452–54 (1930).—The determination of the actual oil condition is only possible by a direct measurement in the oil reservoir by a spark-gap mounted on it. F. describes a suitable measuring device for this purpose and gives a simple method of determining the puncturing strength in kv./cm. in terms of the measured breakdown voltage. The puncturing strength was found to be five times the breakdown voltage in a sample having an electrode radius of 6.25 mm. and a distance of 2.25 mm. M.A.B.

High-tension cable-testing installations with induction regulators. L. TSCHIASSNY. *Electrotech. Z.*, **51**, 392–97 (1930).—T. describes in detail a high-tension cable-testing set. The article also includes a description of a cable-testing and fault-locating set built for the Vienna municipal electrical supply. M.A.B.

How to align pulleys. ANON. *Brick Clay Rec.*, **77** [5], 263 (1930).—The use of a cord rather than a slender pole or board as a straight edge for aligning pulleys is advocated. Illustrated. E.J.V.

How to make conveyers last longer. FREDERICK WEHLE. *Brick Clay Rec.*, **77** [6], 332–33 (1930).—The operator should buy conveyers that are suited for the material to be conveyed and have the capacity required of them. Good engineering of the layout insures rigid and dependable supports to carry the machinery so it will stay in line and so it will be safe and accessible for painting, cleaning, and oiling, all of which means less ultimate cost and longer life. E.J.V.

Speed regulation of rotary cement kilns. E. AUERBACH. *Tonind.-Ztg.*, **54** [38], 635–37 (1930); *Rock Prod.*, **33** [14], 89 (1930).—Regulating the speed of rotary kilns by means of electric motors is discussed. Diagrams and formulas are given for the exact calculation of the speed. M.V.K.

Edge mills. KESPER. *Tonind.-Ztg.*, **54** [57], 945–46 (1930).—K. discusses the use of different types of edge mills for grinding and sifting hard materials and for working moistened heavy clays. M.V.K.

Multi-chamber mills with air separators. A. B. HELBIG. *Zement*, **19** [2], 25–28 (1930); *Rock Prod.*, **33** [17], 90 (1930).—H. describes several screening plants operating on the return-circuit air-separating principle, also in combination with multi-chamber and ball mills. He covers a centrifugal air separator, a pneumatic air separator, a Pfeiffer mill consisting of air separator and ball mill, a tube mill with air separator, and an air separator with intermediate bin. A calculation of the separating process and separating efficiency of a multi-chamber mill equipped with an air separator is given. H. refers to the large Allis-Chalmers mill with air separator, and states that Pfeiffer Bros. Co. built this form of intermediate separator years ago. Illustrated. W.W.M.

Automatic furnace fan control. MERCOID CORP. *Gas Age-Rec.*, **66** [9], 336 (1930).—An automatic fan control, M-53, equipped with the latest development in enclosed mercury contact switches and designed to control the atmosphere of a furnace or oven between the temperatures of 50 °F and 650 °F, is being marketed by the Mercoid Corp., Chicago, Ill. This control will automatically cut the fan in or out, depending on the position of the high and low contact points on the dial. Illustrated. E.J.V.

Expansion switch. F. KESSELRING. *Electrotech. Z.*, **51**, 499–508 (1930).—K. gives the stability equation for an a.-c. arc burning in a vapor in terms of the instantaneous voltage and the absolute temperature. The quenching effect in vapors and the action of the oil switch can be satisfactorily explained from the Wilson effect. The expansion switch, or high-power switch without oil, consists experimentally of a switch situated in a chamber filled with water vapor at a pressure of several atmospheres, connected by a thin tube to a vapor-generating chamber. On breaking the switch, the valve in the switch base opens, giving rise to a rapid expansion of the vapor in the base of the switch and quenching the arc. K. gives details of construction of practical expansion switches for use on circuits up to 100 kv. and 2000 Å, and compares the quenching curves for compressed air and switches. M.A.B.

Modern automatic switches. H. BESOLD. *Electrotech. Z.*, **51**, 350–53 (1930).—The increasing size of industrial power plants and the increased breaking capacities required in the switch gear are discussed. A description is given of various types of automatic switch gear for ratings up to 1100 Å at 500 v. Illustrated. M.A.B.

Synchronous motors for power factor improvement. THOMAS W. HALL. *Brick*

Clay Rec., **77** [4], 212–13 (1930).—Until recently the application of synchronous motors was limited largely to high-speed drives, where the driven machines were started without load. Later, low-speed synchronous motors were used for connection through a suitable clutching mechanism to the load. The principal advantages of synchronous motors are, in general, for high-speed applications (1) power factor correction, (2) higher efficiencies, (3) constant speed irrespective of load conditions, and (4) starting torques comparable with squirrel cage induction motors. In low-speed applications, the first three of the above advantages also hold good. In addition, these motors are available for practically any commercial application and are recommended for automatic starting by means of inexpensive, simple, and reliable across-the-line type, full voltage push button starter. Other advantages of these motors are enumerated and considerable technical data are presented. E.J.V.

Power and heat consumption in sand-lime brick plants. W. LEDER. *Tonind.-Ztg.*, **54** [59], 975–78; [60], 993–95 (1930).—L. discusses the use of steam engines, motors, and electric motors in sand-lime brick plants. Numerous tables illustrate the article. M.V.K.

Artificial drying of ware. J. OHLIG. *Tonind.-Ztg.*, **54** [64], 1051–52 (1930).—Factors which must be taken into consideration when building an artificial drying installation are (1) sensitivity of clays and the difficulty of preparing and drying very sensitive clays, and (2) variation in the rate of drying of different kinds of clays; *e.g.*, fat clays lose moisture slowly, as do brick pressed with a small amount of water. The best results are frequently obtained by combined drying, *i.e.*, predrying in the air with a subsequent artificial drying. The main advantage of a drying installation is that a definite quantity of brick can be dried per day; the difficulty is to obtain uniform drying. An important factor in the efficiency of artificial drying is that the ware predried in air must be dried separately and not together with the ware dried artificially as the behavior during drying of air-dried ware and ware dried artificially is not similar. M.V.K.

Promal—new metal for chains. LINK-BELT CO. *Gas Age-Rec.*, **66** [9], 337 (1930); see also *Ceram. Abs.*, **9** [10], 862 (1930). E.J.V.

Equipment of an "ultra-modern" French plaster plant. J. PROUTEAU. *Rev. mat. constr. trav. pub.*, No. 237, pp. 201–205 (1929); *Rock Prod.*, **33** [13], 94 (1930).—In 1923, the firm Jannot of Triel-sur-Seine, started, in agreement with the firm Vernon of Paris, to build driers and rotary kilns and also special rotary burners for gypsum plasters. At present the firm has at least 25 installations to its credit, in capacities from 2 to 12 T. per hour. An illustration shows the installation of a plaster plant for the production of 5 T. per hour. It contains the following equipment: jaw crusher, grinder with perforated floor, reserve hopper for ground gypsum, rotary disk distributor, spiral conveyer, feed to kilns, two rotary kilns for building plaster, grinder with perforated floor for burned plaster, elevator, bolting mill for fine plaster for coating, feeding screw of bolting mill, and discharge for fine coating plaster. Special blades are attached to the inside lining of the tube to help deliver the gypsum to the opposite end. W.W.M.

Use of light to control machinery. ANON. *Mining and Met.*, **11** [285], 447 (1930).—The interruption of a beam of light controls the operation of industrial machinery, opens and closes a door, and performs other similar work, by utilizing the photoelectric relay of the General Electric Co. The new relay is essentially a vacuum tube and uses both the photoelectric tube and the pliotron. E.J.V.

Mining and milling barite. GEORGE J. YOUNG. *Eng. Mining Jour.*, **130** [2], 70–71 (1930).—Operations of the National Pigments Co., Calif., are described. E.C.C.

Packing glass and porcelain ware for export by sea. ANON. *Glashütte*, **60** [31], 564–66 (1930). L.T.B.

Cartons for pottery. II. ANON. *Pottery Gaz.*, **55** [639], 1442–44 (1930).—Illustrated. For Part I see *Ceram. Abs.*, **9** [10], 864 (1930). E.J.V.

BOOKS AND BULLETINS

Die-Casting Practice. MARC STERN. McGraw-Hill Book Co., New York, 1930. 270 pp., illustrated. $2.50. Reviewed in *Mining and Met.*, **11** [285], 14 (1930).—The application of die castings and their design, the design and construction of dies, suitable alloys, die machines, production methods, finishes, and the limitations and possibilities of the process are discussed. E.J.V.

Filtration and Filters. An Outline of the Art. J. A. PICKARD AND A. J. V. UNDERWOOD. 481 pp. Reviewed in *Engineering*, **130** [3369], 164 (1930); for abstract see *Ceram. Abs.*, **9** [4], 298 (1930). A.A.

Humidity recorder. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—A direct-reading humidity recorder is described in a bulletin by the Leeds & Northrup Co. In this device it is not necessary to consult a table to translate the relative temperature of wet- and dry-bulb thermometers, the relative humidity being recorded directly. A sample chart is included and illustrations show the construction and operation of the device. E.P.R.

PATENTS

Humidity control. CARROLL E. LEWIS. U. S. 1,772,611, Aug. 12, 1930. Humidity controlling mechanism comprising an absorbent element rectilinearly expansible or contractible with variations in the humidity of the air to which it is exposed, means for anchoring one end of the element, the opposite end being movable with the humidity variations, a bell crank lever having a relatively short arm and a relatively long arm, the short arm being fulcrumed adjacent its outer end and having its intermediate portion yieldingly held in contact with the movable end of the expansible element, an oscillatory switch connected with the outer end of the longer arm, and adapted to be tilted by the movement of the arm to make or break an electric circuit.

Measuring the concentration of solids in liquids. HOWARD J. KERR. U. S. 1,773,735, Aug. 26, 1930. The method of measuring the concentration of solids in a liquid body subjected to pressure which consists in continuously withdrawing liquid from the liquid body to form a pool with a free space above the pool, maintaining the pressure above the pool substantially constant and lower than that of the liquid body, maintaining the liquid in the pool at the boiling point, and measuring electrical conductivity of the liquid in the pool.

Trimmer for pottery machines. JOHN M. STRAND. U. S. 1,775,215, Sept. 9, 1930. A pottery-making machine comprising a fixed mold, a rotatable core, an axially movable collar on the core, and a plurality of vertically arranged cylindrical pins supported by the collar for trimming excess material ex-pressed between the mold and the core.

Drying refractory materials. W. J. GARDNER. Brit. 330,447, July 30, 1930. In a drying stove for refractory goods, the goods are passed longitudinally through a chamber divided by partitions into compartments which are heated by steam coils to temperatures increasing successively toward the outlet from the chamber, air is admitted to each compartment through adjustable bottom openings and withdrawn through adjustable top openings and fans in the chambers to agitate or swirl the air that it is directed against the goods from all directions.

Drying of ceramic products. J. KOTTERBA. Ger. 461,077, Aug. 1, 1925. The articles are placed in chambers with perforated bottoms through which the hot drying air is introduced under pressure and the wet air is withdrawn. The hot air

rising in the chambers is thus moistened by direct contact with the gravitating moist air leaving the same, so that the articles are not brought into contact with hot dry air, whereby drying merely the outer layer, with consequent nonremoval of the interior moisture, is prevented. The dried articles are free from cracks. (*B.C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Thermal insulation of brick, tile, and pipe kilns. C. PRESSWOOD. *Trans. Ceram. Soc.* [Eng.], **28** [11], 436–44 (1929).—The modern furnace wall is composite in structure, comprising three parts: (1) an inner highly-refractory lining, (2) a layer of insulation, and (3) an outer shell. For the insulation of a kiln, diatomaceous earth is available in brick, either cut from raw earth (when this occurs sufficiently compressed as in the Calif. deposits) or fired; powder, either raw or calcined; and aggregate, which is calcined lump material crushed and graded suitable for use in insulating concrete. Brick can be used in any position, but powder is especially useful as avoiding the use of special-shaped brick in places where the mechanical strength of the powder can be increased with slight loss of insulating value by the judicious use of Portland cement, and it is often easier and cheaper to fill in the space between inner and outer walls with powder than to use brick. Fired brick are to be preferred in all places where temperature is likely to be high enough to cause shrinkage in raw material and should be set so that natural laminations or bedding planes are horizontal. Calcined powder should also be used in preference if it is to be exposed to temperatures higher than 500°C. The use of aggregate is strongly recommended in places where mechanical strength is required as in the foundations of kilns, the loss of insulating efficiency due to use of cement being off-set by increased thickness of insulation. Powder is specially suited for lagging kiln crowns, in which position the material does not bear any load. The joints of insulating brick should be carefully considered. It is advisable to grind the insulating brick correctly to shape and size and to use no jointing material. It is unnecessary and undesirable to soak the porous brick in water before setting. It is important to insure that insulating materials do not shrink at temperatures below 900°C minimum. The best test of insulating efficiency lies in thermal conductivity figures, the better brick having the lower conductivity. In the use of powder, the conductivity varies with the degree of ramming and the material should be rammed neither too hard nor too lightly. The foundations of the kiln are laid with ordinary concrete. Flues are insulated and other insulation is described. R.F.S.

Note on molybdenum wire-wound furnaces. C. SYKES. *Trans. Ceram. Soc.* [Eng.], **29** [2], 55–60 (1930).—Of various types of furnaces available for operation over the temperature range 1100 to 1650°C, the molybdenum-wound furnace is probably the most suitable for research purposes. The furnace temperature may be accurately controlled, the furnace itself is not liable to hot-spot, and the specimens may be protected from carbonaceous matter and oxidizing gases. A description of furnaces designed by S. for metallurgical and other work is given. An alundum tube carrying the heating unit is placed inside a larger and concentric tube, the whole being mounted in a steel casing containing the necessary heat insulation. The various parts of the casing are bolted or screwed together, using heat-resisting washers which allow the completed casing to be made gas-tight. This design permits a free and rapid circulation of inert gas over the winding and prevents slagging of the winding by the material used for heat insulation. The "inert" atmosphere used to protect the winding from oxidation is cracked ammonia, and the train recommended has proved to be reliable. The winding leads are brought out through porcelain bushes; other electrical insulation deteriorates rapidly in the region of the furnace. The furnace in general is operated

with top and bottom cap in position to obtain a more satisfactory gas circulation, *e.g.*, the cracked ammonia is passed in at the top and allowed to leak out through the bottom from two exits, one in the case and the other in the bottom cap. This method is only disadvantageous when it is necessary that the specimen be removed while the furnace is hot. The top cap may be modified for visual observation or for temperature measurement with a thermocouple. The couple may be moved up and down quite freely without danger of air leakage, provided the mounting makes a good fit with the cap. Less gas is required when this method is adopted and the furnace may be operated either horizontally or vertically. The limiting temperature of the furnace together with the power input depend on the ratio of lagging thickness to tube diameter. The limiting temperatures seem to vary from 1750°C for a 1-in. tube to 1650°C for a 4-in. tube. As the temperature coefficient of molybdenum is high (1200°), the winding resistance serves as a good indication of the temperature of the furnace. It compares favorably with the nichrome furnace in regard to reliability and forms a useful piece of apparatus for investigations necessitating temperatures in excess of 1050°C. See also *Ceram. Abs.*, **9** [6], 448 (1930). R.F.S.

Mechanical stoking of kilns. JOHN PROCTER. *Trans. Ceram. Soc.* [Eng.], **29** [3], 94–96 (1930).—Instead of intermittent and haphazard stoking, the feed can be regulated to the requirements of the kiln and its contents. Usually the cheapest and smallest mesh coal is used, and it must be dry. It is screened through a $^1/_8$-in. mesh. The tailings can be used for steam raising. The coal when prepared is loaded by hand into the hoppers of feeding machines which deliver the coal as required into the firing zone of the kiln. These machines are chain-driven and each machine is a fixture for its particular part of the kiln. The power required is small (1 h.p. motor). Under hand-firing each feedhole is used, while in mechanical firing it is the usual practice to use alternate rows only. The feedhole rows not used for firing are used for observation purposes and the ordinary hand-firing passages are still left through the setting so that hand-firing can be operated in case of mechanical breakdown. The setting under the feedholes that are mechanically fed is greatly altered. The ordinary parallel passage in the setting for the falling fuel is not used. In its place is an opening under each feeding in shape of an inverted cone, about 18 in. sq. at the top and 9 in. sq. at the bottom. On the kiln top, the coal-feeding machines are so placed that 4 feeds can be obtained from each machine. Each feed can be regulated to any requirement. Connection between feedhole and machine spout is made with a removable pipe which leads from the machine spout to an opening in the brickwork leading into the feedhole under the lid and ring. This opening in the brick is the only structural alteration made to the kiln, and when not in use is closed by a lump of clay. Firing is accomplished by feeding the coal into the chamber in a regulated and continuous quantity. As the coal is prepared and dry for use and is in fine particles with a maximum of $^1/_8$ in. down to an impalpable dust, combustion begins as soon as it has passed the ring of the chamber arch. The fine dust fires first and is carried by the draft among the ware. The heavier particles fire on the way to the floor and burn there. The result is an even heat from top to bottom. The fine ash dust does no damage to the ware unless its fusing point is lower than the heat required for firing brick. The pyrometer record shows a continuous rise in heat without any fluctuations except those due to stoppage or damper alteration. The rate of heat travel is increased, a speed of 40 ft. per day in a kiln with a 17-ft. fire front being quite common. By overfeeding, it is an easy matter to turn the chamber contents into a solid mass of waste. With care there is no need for waste to be any more than negligible. Experienced help is necessary. Kiln production is at least doubled. See also *Ceram. Abs.*, **9** [1], 55 (1930). R.F.S.

Sustaining 2750°F in a reduction furnace. WILLIAM F. ALLEN AND GEORGE J.

O'NEILL. *Gas Age-Rec.*, **66** [7], 229–30 (1930).—Details of the construction of a reduction furnace in which a temperature of 2750°F is being maintained with a variation of only about 10° ± for time periods ranging from 24 to 48 hours are given. This is a pit type furnace with interior dimensions of 15 x 42 x 20 inches, constructed of silicon carbide refractories for the piers and hearth, and a dense machine-pressed brick of 52% silica and 43% alumina, with a fusion point of 3254°F, whose volume change was claimed to average only 0.5%, and fired with five Surface Combustion tunnel type burners. Illustrated. E.J.V.

Electric melting and pouring furnaces. REINHOLD GROSS. *Siemens-Z.*, **9**, 772–79 (1929).—Electric arc furnaces of the Héroult type are described; they range from 500 kg. to 15 T. capacity. The 15 T. furnace is fed from a 5500-kv.-amp. transformer and operates on a power factor of 0.8. For fusion, 180 v. is used; for refining, 101 v. Pt requires 450–500 kw.-hrs. for melting; 160–200 kw.-hrs. for refining. Counterweights help the motors raise and lower the arms supporting the electrodes. Above the roof of the furnace the electrodes are surrounded by a water-cooled, air-tight Cu cylinder whose lower ends reach into a water-cooled sand bath that makes a flexible joint with the furnace roof. The current regulators are of the Westinghouse type. A low-frequency furnace for remelting is described. Its performance remains constant throughout the life of the furnace. A high-frequency furnace is described. (*C.A.*)

Function of air in an annular kiln. ANON. *Corriere ceram.*, **11** [7], 275–81 (1930).—Air is a more important factor in the transmission of heat than radiation, and as it serves the dual purpose in annular kilns of heating the ware and carrying off the humidity, its distribution, temperature, and volume are of great importance. The hotter the air, the less is required, but a corresponding increase in the velocity is necessary to prevent the lower part of the kiln from cooling and condensation occurring. Regular distribution of air and gas is another essential. Combustion will be the most economical if only the exact proportion of air necessary for perfect and complete combustion is admitted. These conditions are not always possible in an annular kiln and the difficulties can usually be attributed to a poor draft. In the cases of kilns with no artificial ventilators, but depending entirely on the chimney for draft, the temperature of the gas leaving the kiln at the base of the chimney should be the same as that of the last smoking chamber; 100°C is reputed normal. When the temperature falls below this, the chimney draft is diminished and condensation occurs; also, at lower temperatures the sulphuric gases combine with water and injure the ware. Further directions for increasing the efficiency of an annular kiln are given. M.V.K.

Recent trend of ceramic kiln practice. S. R. HIND. *Fuel Econ. Rev.*, **9**, 89–97 (1930). (*C.A.*)

Heat management in glass factories. ANON. *Sprechsaal*, **63** [30], 561–63; [31], 583–86 (1930).—Process of firing is discussed and examples are demonstrated showing how mistakes in heating occur. M.V.K.

New high-temperature gas-fired furnace. HEAT ENGINEERS, INC. *Gas Age-Rec.*, **66** [10], 381 (1930).—These furnaces are constructed so as to permit burning large quantities of gas in a limited space without the necessity of high pressures and velocities. They develop high temperatures, yet can be easily controlled and precisely maintained. The combustion process is isolated, thereby removing the interference between gas combustion and heat propagation and utilization. Illustrated. E.J.V.

Control of mixed-gas furnaces. KARL A. MAYR. *Iron Age*, **126** [4], 225–28 (1930).—Automatic regulation of air supply for burning different kinds of fuel simultaneously is described. E.C.C.

Calculating heating value from chemical compositions. H. L. KAUFFMAN. *Gas Age-Rec.*, **66** [10], 372 (1930); for abstract see *Ceram. Abs.*, **9** [9], 768 (1930). E.J.V.

Multiburner kiln promises better firing. ANON. *Brick Clay Rec.*, **77** [4], 218–19 (1930).—The multiburner type of tunnel kiln developed by the American Dressler Tunnel Kilns, Inc., differs from the usual firebox type in that the fuel is applied through a large number of small burners instead of the usual 10 or 12 fireboxes. The kiln is 406 ft. 6 in. long and joins with a tunnel preheater 141 ft. long, capable of holding 17 cars. The furnace zone of the kiln occupies a length of 130 ft. which is more than one-third of the total length of the kiln. There are 104 burners in this section, 52 on each side, and natural gas is used in this installation. The heating and cooling of the kiln is explained in detail. Illustrated. E.J.V.

Use of fuels in ceramic kilns. ANON. *Queensland Govt. Mining Jour.*, **31** [7], 298 (1930).—A series of tests designed to improve the efficiency of utilization of fuels in ceramic kilns is being conducted at the new paving brick plant of the Ohio Penitentiary at Roseville, Ohio. The first tests of the series are being made on two 32-ft. round, downdraft kilns fired with bituminous coal on an overfeed stoker in a small furnace adjacent to them. Tentative plans for future tests include the use of coal in other types of furnaces, pulverized coal, oil, natural gas, and producer gas. The investigation is planned to advance the art of firing kilns by study of the relation of the method of firing to the construction of the kilns and conditions in the kilns. Features which will be studied include design of furnaces, design of systems of flues, control of drafts and pressures, uniformity of distribution of heat, and quality of ware produced. E.P.R.

Combined firing. P. KREBS. *Feuerungstechnik*, **18** [11–12], 109–11 (1930).—Coal dust is frequently used in combination with other fuels to supplement or increase their duration or to replace them temporarily. Methods of installing and ways of combining coal-dust firing with grate firing of all types, and with oil, gas, or waste-gas firing, are described. M.V.K.

Laboratory air separator. ANON. *Ceram. Ind.*, **15** [2], 199 (1930).—The Federal Pneumatic Systems, Inc., Chicago, is manufacturing an air-separating unit embracing centrifugal separator and Federal closed circuit collector, together with fan and universal motor operated from an ordinary 110-v. lighting circuit. There are no screens or moving parts, classification being effected by two opposing centrifugal currents of air. The apparatus handles about 2 lbs. of feed material per min. Illustrated. W.W.M.

Accurate and flexible control of kiln heat. F. H. JOHNSON. *Bull. Amer. Ceram. Soc.*, **9** [9], 267–68 (1930); *Clay-Worker*, **94** [2], 108–109 (1930).—In the Forester system of kiln control, heat effect is determined by measurement of shrinkage of specially standardized clay materials. It comprises two units: the clay test piece in the form of a wedge called the Forester Key, and a special gage which accurately measures the shrinkage of the key. The similarity in the behavior of Forester keys during the firing procedure to the behavior of the clay ware gives this system many advantages. It affords an accurate record of the condition of the product at all times and from as many sections of the kiln as is desired, indicates faults in the firing and inequalities in various parts before the firing has proceeded far enough to do damage, and directs attention to the part of the kiln where the correction may be made. It will detect reduction or flashing and a set of keys drawn during a firing comprise a heat chart to be followed and thus makes it possible to duplicate a previous firing. The wedges are not influenced by slight disturbances such as electric storms, changes in outside temperatures, sulphuring, or sudden drafts, but are affected only as the ware itself is affected and are a true comparison to the ware itself. E.J.V.

Unit heater burns gas. BUFFALO FORGE CO. *Brick Clay Rec.*, **77** [6], 333 (1930).—The Buffalo gas heater is a recent development. This heater has several advantages

over the steam-unit heaters: it is light, compact, and easily suspended, and requires no boiler room or heat manufacturing facilities. Operating labor expense is negligible due to push button control on the unit which has a maximum heat input of 150,000 B.t.u. per hour and requires approximately 160 cu. ft. of 900 B.t.u. gas per hour for this input. E.J.V.

Heat balance in producer gas-fired glass tanks. JOHN W. ROMIG. *Ceram. Ind.*, **15** [3], 290–92 (1930).—R. states that the greatest heat losses from producer gas-fired glass tanks are those due to radiation and waste-stack gases. Radiation losses can be reduced by insulation, but the present refractories will not stand sufficient insulation. Data on heat balance for a continuous regenerative glass tank, separating the heat consumption into various items, are given. Only about 15% of the heat dissipated is used in melting the batch. Suggestions for minimizing some of the heat losses are given. See also *Ceram. Abs.*, **9** [10], 834 (1930). W.W.M.

Fuel saving with stokers. J. C. HUTCHINSON. *Brick Clay Rec.*, **77** [6], 310 (1930).—Ayer, McCarel & Reagan, of Brazil, Ind., manufacturers of hollow-ware, report a 40% saving in fuel as a result of installing two automatic stokers of the "Pulverzone" type under their boilers. The 40% saving consists of an outright saving in the quantity of fuel required, the quality remaining the same. Approximately two-thirds of the coal fed from the hopper is burned in suspension, the stoker fuel beds burning only the residual carbon. This intensely hot fuel bed, together with the turbulence developed in the stoker, accelerates the rapid combustion of the fine and small size coal which is ordinarily too large to be burned in a pulverized coal furnace which has no stoker grate. The coal not burned in suspension is burned on the stoker grate, which is an integral part and located at the bottom of the furnace. Illustrated. E.J.V.

Removal of ash from flue gases. ANON. *Engineering*, **130** [3368], 150 (1930). A.A.

Calculation of heat flow in rotary cement kiln. A. B. HELBIG. *Zement*, **19** [19], 440–44 (1930); *Rock Prod.*, **33** [17], 91 (1930).—The G. Polysius Company has succeeded in burning 220 lbs. of cement in a rotary kiln by using 400,000 B.t.u. A kiln 79 ft. in length and of 6.9 ft. diameter produced 100 long T. of clinker in 24 hours. The raw material is granulated, dried, and more or less decarbonated before it enters the kiln. These results enable H. to determine whether the new kiln is more economical than the rotary kiln equipped to utilize the waste heat. By making an extensive calculation of the heat flow, he offers proof that the rotary kiln with utilization of waste heat is unconditionally superior to the Lejol kiln. W.W.M.

Calculation of convection heat transfer. MARGARET FISHENDEN AND O. A. SAUNDERS. *Engineering*, **130** [3360], 177–80 (1930). A.A.

Use of powdered coal and crude oil in the rotary cement kiln. ALTON J. BLANK. *Rock Prod.*, **33** [18], 53–54 (1930).—B. gives data from various plants on consumption of powdered coal vs. crude oil, in terms of B.t.u. per barrel of clinker produced. He stresses the importance of intelligent kiln firemen and states that refractory linings last longer in coal-fired kilns than in those fired with oil, due to a difference in operating temperatures, which is usually higher in the oil-fired kiln. W.W.M.

Temperature measurements in gaseous combustion. W. T. DAVIES AND W. DAVIES. *Phil. Mag.*, **9**, 402–14 (1930).—Experiments are described in which the temperatures of thin platinum-rhodium wires immersed in inflammable gaseous mixtures during their explosion in closed vessels were recorded continuously and compared with the gas temperatures as inferred from the pressures. The experimental procedure is described and a sketch is given of the general arrangement of the apparatus for recording the temperature of the wire within the explosion chamber. It is found that in whatever position the wire is placed its temperature is much higher (sometimes 500°C) than that of the gas. Curves are given to illustrate results of definite experiments.

some of which were made in the cylinder of a gas engine designed to give the Clerk "zigzag" indicator diagram. The explanation given for the large difference existing between the wire temperature and the gas temperature and continuing long after chemical combination has been completed, is that combination in the gaseous phase results in the formation of long-lived abnormal molecules, and that considerable energy is associated with these molecules, which can be unloaded upon the surface of a hot wire when they come in contact with it. M.A.B.

Luminosity in gaseous combustion. W. T. DAVIES AND W. DAVIES. *Phil. Mag.*, **9**, 390–401 (1930).—Gaseous mixtures are exploded in closed cylindrical vessels, and simultaneous records are obtained of the pressure-time curve and of the luminosity of the gas. It was found that during the actual explosion the luminous radiation emitted was of no greater intensity than that emitted immediately after the moment of maximum pressure, although the bulk of chemical combination took place during that period. Luminosity was manifest in the exploded gases long after chemical combination was completed. Since more permanent gases cannot be rendered luminous by direct heating to temperatures at which luminosity is manifest, it is concluded that chemical combination results in the formation of abnormal molecules, and the vibrations giving rise to luminous radiation are excited by softer collisions than in the case of normal molecules. M.A.B.

Graphical comparison of heat loss in flue gases and their CO_2 content. A. ALISON. *Glass*, **7** [7], 272–73 (1930).—The measurement of the carbon dioxide present in flue gases is an important part in all boiler efficiency tests. The maximum percentage of CO_2 is yielded when all of the oxygen in the air is used and all of the combustible matter in the fuel is consumed. The percentage loss that takes place by way of the flue gases is shown by the equation by Prat: $P = 0.37 \frac{(T - t)}{A}$, in which P = percentage heat loss; T = temperature of flue gases in °F; t = temperature of air in °F; and A = percentage by volume of CO_2 in flue gases. The chart is a logarithmic one. The development of the chart and the chart itself are given. H.W.A.

Use of oxygen in the manufacture of producer gas. A. E. R. WESTMAN. *Can. Chem. Met.*, **14** [8], 17–21 (1930).—The use of oxygen in gas manufacture has been of recurrent interest in America for ten years. Laboratory and semi-commercial experiments have shown the chemical and economic difficulties. A comparison is made under ideal and semi-ideal conditions, of 3 processes for the manufacture of gas from coke: (1) the air-producer, (2) oxygen-producer, and (3) water-gas processes. From this comparison the following conclusions are drawn: (1) the presumably higher efficiency of the oxygen producer would not ordinarily pay for the oxygen; (2) the potential high capacity, adaptability, etc., of the oxygen producer would be advantageous if a solution of the chemical problems were obtained; (3) large scale experiments would be required to determine capacity; (4) the main chemical problem is to provide heat transfer from the oxidation to the reduction zone; (5) the economic feasibility of a technically successful oxygen producer would depend on the extent to which the potentially high capacity was realized; (6) when used with present distribution systems the high cost of oxygen and the necessity of carbureting would militate against the oxygen producer; (7) the oxygen producer would deserve consideration in a scheme for distributing gas from deposits of fuel unsuited for retorting or for use in water-gas generators. Illustrated. E.J.V.

Influencing the CO_2 content of waste gases. HANS JÖRRIS. *Feuerungstechnik*, **18** [15–16], 155–57 (1930).—Experiments were made on preheaters with smooth and ribbed pipes to determine the cause of the entrance of cold air, its effect on the efficiency, and the necessary precautions to take. M.V.K.

Advantages of gas generators with revolving grates. H. WINKELMANN. *Chem. Tech. Rundschau*, **44**, 762 (1929); *Sprechsaal*, **63** [35], 667 (1930).—The advantages of revolving-grate generators over shaft-grate generators are (1) more complete combustion of heat and (2) a smaller space is required. For gasifying coke, the revolving-grate generators with a high-pressure steam generator are good; the steam produced by these generators is used for steam turbines, while only the waste steam is used for generating gas. Data for the consumption of different fuels for 24 hrs. are given. M.V.K.

Problem of gas drying. ROBERT MEZGER AND FRIEDRICH PISTOR. *Gas Age-Rec.*, **66** [9], 310–16 (1930); translated from *Gas und Wasserfach.*—The water content of gas is discussed from a theoretical standpoint. The advantages of gas drying, disadvantages, and their elimination are enumerated. The following processes of gas drying are discussed in detail: (1) dehydration by simultaneous compression and cooling; (2) dehydration by cooling; (3) dehydration by adsorption (silica gel); (4) dehydration by hygroscopic liquids or solution, *e.g.*, (*a*) sulphuric acid, (*b*) glycerin, (*c*) calcium chloride solution, and (*d*) sodium thiocyanate. E.J.V.

Correction of gas flows. FRED M. REITER. *Gas Age-Rec.*, **66** [9], 325–26 (1930).—Explanation of the corrections of gas volumes of a definite weight of gas under the various conditions of temperature, specific gravity, and total pressure is given. Some short methods of obtaining the correction factors, their derivation and application are presented. Illustrated. E.J.V.

Properties of liquefied petroleum gases. LYMAN M. VAN DER PYL. *Gas Age-Rec.*, **66** [8], 265–69 (1930).—With the increased use of this type of fuel, this summary of the various chemical and physical properties of the paraffin series of hydrocarbons is of considerable interest. E.J.V.

Primary thermal decomposition of coal. R. HOLROYD AND R. V. WHEELER. *Gas Age-Rec.*, **66** [7], 254 (1930); abstracted from *Fuel in Science & Practice.*—A study of the thermal decomposition of coal was made. Coal was distilled in stages as follows: (1) evacuation for 50 hrs. to remove H_2O; (2) 0–100°; (3) 100–200°; (4) 200–275°; (5) 275–300°; (6) 300–325°; (7) 325–350°; and (8) 350–400°. The duration of heating of each stage was 120 hrs. The coal was sized to 20- to 50-mesh and 250-g. samples were used. Each experiment required approximately six weeks continuous operation. The gases, tars, and water evolved over each temperature range were collected and estimated. With most bituminous coals containing more than 80% C, there is little decomposition of any constituent below 300°. Occluded gases are driven off up to 150°, and decomposition of the external groupings of ulmin compounds may occur at low temperatures, particularly in weathered coal. Between 220° and 300°, the major part of the free hydro-carbons (γ compounds) distills unchanged. At 300°, any plant impurities present in the coal begin to decompose. The gases are rich in oxides of C and the liquids consist of H_2O with unsaturated hydrocarbons and neutral oxygenated compounds. This decomposition occurs from 310 to 350° with most bituminous coals. Well-defined decomposition of the ulmin compounds may be noted at 290 to 365°. Resins are distilled and decomposed from 325 to 375°; the amount of resins distilled unchanged is usually less than that extractable from the coal by solvents. Above 400° the gas yield increases rapidly. Compounds of N and S appear in both gaseous and liquid products at all temperatures. See also *Ceram. Abs.*, **8** [5], 357 (1929). E.J.V.

Fundamentals of wetting-down coal. R. K. LONG. *Power*, **72** [7], 255 (1930).—Information is given which may be of value to plants to check on the use of water for wetting-down, and to know to what extent this experience may be applied to minimize the amount of water and so minimize the loss of heat due to its evaporation and de-

composition. Time is an element in the effectiveness of wetting-down coal. Hot water is often better than cold for wetting-down. H.W.A.

Carbonization of coal. ETIENNE AUDIBERT. *Colliery Guardian*, **141** [3632], 478–79 (1930); abstracted from *Rev. Ind. Minerale*.—The paper on French researches in this field is divided into various sections, *i.e.*, physical study of the fusion of coal; the agglomeration of a heap of coal grains, uniformly heated; agglomeration in the coke oven; and the fragmentation of coke into needles. A description of theoretical and experimental work done on French coals is given. Illustrated. E.J.V.

Low-temperature carbonization. The positive retort. ANON. *Colliery Guardian*, **141** [3630], 301–302 (1930).—The details of construction and operation of this new type retort for carbonizing coal are described. Illustrated. E.J.V.

Coals in the ceramic industry. I. C. W. PARMELEE AND R. K. HURSH. *Blast Fur. Steel Plant*, **18** [9], 1506–12 (1930); see also *Ceram. Abs.*, **9** [7], 559 (1930). E.J.V.

Coking power and swelling of coal. H. A. J. PIETERS. *Gas Age-Rec.*, **66** [7], 237 and 256 (1930); abstracted from *Rec. trav. chim.*, **49** [4], 289–306 (1930).—Knowledge of the coking properties of a coal may be obtained by determining its volatile matter, *e.g.*, heating 1 g. of the coal at a temperature of 850°C for a period of $2^1/_2$ minutes. The volume of the coke button and its Campredon caking index are determined, as well as the softening point when heated at a rate of 9° per minute. Its swelling power is determined when the coal is heated at the rate of 5° per minute under pressure. The temperature at which rapid evolution of gas begins and the rate at which the gas is evolved when 2 g. of coal are heated at the rate of 4° per minute are other methods. Tests on 28 coking, noncoking, and gas coals showed that a correlation may be made between the amount of volatile matter in the coal, its caking index, and the volume of the coke button, high volatile matter corresponding to high caking index and a large coke button volume. For coals with a gas content of 18 to 25%, the coking and swelling properties are a function of their volatile matter content, but with coals having a gas content of about 30% and with certain blends of coal this relationship no longer holds. Coking coals give lower softening points and commence to evolve gas at lower temperatures than low volatile noncoking coals; they also begin to swell considerably and to soften at 360 to 420°C. When the plasticity diminishes, the swelling decreases and the volume of the coal becomes constant, but at a temperature of 650 to 825°C a definite shrinkage occurs. A noncoking coal gradually shrinks during the whole period of its destructive distillation. Gas coals give low swelling values when tested in an open crucible, and when coking takes place under pressure, these coals show only a temporary swelling and afterward shrink. E.J.V.

Coking and noncoking coals in the water-gas generator. T. W. WEIGELE. *Gas Age-Rec.*, **66** [8], 271–74 (1930).—Considerable experimental work with the use of bituminous coal for water-gas production was carried on. Due to the physical and chemical properties of bituminous coal and its behavior in the water-gas generator, changes had to be made in the operating cycles, rates of steam and air admission, and methods of clinkering before economical fuel and oil results could be obtained. Bituminous coals with different physical and chemical characteristics behave differently in the water-gas generator, each coal requiring a special set of conditions with respect to cycle, steam, and air rates to secure the best results, and each coal appearing to have a different economic value. Data on some specific coals are given. E.J.V.

Influence of washing coal on coke properties. A. C. FIELDNER. *Colliery Guardian*, **141** [3632], 509 (1930); see also *Ceram. Abs.*, **9** [9], 775–76 (1930). E.J.V.

Reactivity of coke. ANON. *Engineering*, **130** [3371], 251 (1930). A.A.

Oil and pulverized fuel. EDWIN COLE. *Queensland Govt. Mining Jour.*, **31** [7],

297–98 (1930).—The use of coal in the pulverized form is compared and contrasted with the uses and advantages of other forms of coal and oil. The advantages in using oil over the use of pulverized or other forms of coal are given. E.P.R.

Determining melting point of ashes. M. DOLCH AND E. PÖCHMÜLLER. *Feuerungstechnik*, **18** [15–16], 149–51 (1930).—The description of a simple apparatus for observing the behavior of ashes during fusion and vitrifying and for measuring the fusion temperatures of different substances is given. M.V.K.

Yard sticks for fuels. EDGAR STANSFIELD. *Can. Chem. Met.*, pp. 22–24 (1930).—The need for new or more definite yard sticks for fuels is stressed. There are many standards of measurement in which more careful definition is required, and there are also measurements for which an agreement is needed as to the best standard to be used. As new types of fuels are marketed, new uses are discovered, new properties of fuels are considered, and new standards must be adopted. The various tests made on the following properties are discussed: calorific values, proximate coal analysis, specific gravity, weathering, solubility, oxidizability of coals, evaluation of the relative ignition temperatures of different coals, the softening temperature of a coal, the decomposition temperature of coal, etc. E.J.V.

Pulverized fuel firing. VERNON WALKER. *Electrical Rev.*, **107** [2749], 171–72 (1930).—A review of the progress made in the combustion of powdered coal, as indicated by the report for 1928–29 of the Prime Movers committee, Engineering Section, of the National Electric Light Assn. of New York, is given in this article together with descriptions and discussions of various pulverized fuel-fired installations. E.P.R.

New Foxboro differential limit controller. FOXBORO CO. *Gas Age-Rec.*, **66** [10], 381 (1930).—A new instrument called a differential limit recorder-controller is designed for meter flow that is varying over so wide a range that a wide-range meter will not permit satisfactory readings. The differential limit controller continually gives a record of the gas flow through the line. This controller is known as the primary meter and it is specified to handle the minimum rate of flow with commercial accuracy. When the differential range is exceeded, the control functions and automatically opens a valve which puts the secondary meter in operation. When the secondary meter goes into operation it doubles the effective capacity of the set-up. As soon as the secondary meter line is open the differential pressure drops because of the increased capacity. The valve in the secondary meter line is held open by the controller until the flow is again within the capacity of the primary meter. The valve is then closed automatically and the primary meter again assumes the entire load. The operation is automatic. Illustrated. E.J.V.

Alliance Clay Products Co. ANON. *Brick Clay Rec.*, **77** [4], 210–11 (1930).—A labor saving of $90 to $100 per kiln, a time-saving of one to two days on every kiln, and an increase in the percentage of good brick are recorded by the Alliance Clay Products Co., Alliance, Ohio, after 6 months firing operations comparing performance of coal- and gas-fired kilns. Six gas-fired kilns are now in use. Two burner systems, the high-pressure and low-pressure are used. Illustrated. E.J.V.

BOOKS AND BULLETINS

Brick Firing. Theory and Practice. (Ziegelbrennen. Theory und Praxix.) LAURITZ ANDERSON. A. B. Bergstens, Hälsingborg, 1930. 46 pp. Reviewed in *Tonind.-Ztg.*, **54** [58], 971 (1930).—Chapter I contains the composition of clays and the influence of iron oxide and lime on the coloring of clay by reduced and oxidized firing. An analysis table gives examples for the composition of three typical red-fired clays of middle Sweden, a red-fired clay of south Sweden, and a Swedish yellow-fired clay. Chapter II is devoted to the theory of brick firing. The reactions appearing during this process are divided into three stages: The first stage, smoking or preheat-

ing to redness, includes (1) expelling hygroscopic water or water of pores; (2) combustion of organic (bituminous) substances; (3) expelling a part of the sulphur from the eventually present iron pyrites (change of chemical compounds into sulphates); (4) expelling chemically-combined water; and (5) expelling carbonic acid from carbonates. The significance of careful and thorough smoking is emphasized and the injuries and faults resulting from incomplete smoking are given. The remaining points of the first stage are briefly described. It is proved by curves that at the expiration of this stage, *i.e.*, after reaching a good red heat at 600 to 700°, the porosity of brick is greater than at any other stage. Besides the pores, which originate from the expulsion of water from air-dried clay, there are also pores resulting from the combustion of organic substances, and from the loss of chemically-combined water, also from the loss of carbonic acid from carbonates, and from the beginning of the expulsion of sulphur. On the other hand, the shrinkage has not yet begun and the clay is still soft. From investigations in a Swedish laboratory (tests are shown in a curve) it was found that between 500° and 550° the solidity of the weakly-fired brick is considerably greater than that of brick fired at 700°. Practice shows that brick which have been thoroughly smoked in a kiln appear to be hard and already give a good sound, but when they turn light red they become soft and lose their sound, only later regaining it. The second stage, the oxidation process, is of special significance for the Swedish brick plants as they work almost exclusively with red-firing clays with a high content of iron. The chemical reactions of this stage are explained. A good oxidation is obtained in practice (1) when the kiln charge is well dried, (2) when the heating to redness is delayed till the brick are completely dried and warmed up, (3) when the temperature is slowly raised from 600 to 800°, and (4) when the work at this stage is done with the greatest possible surplus of air. After a thorough oxidation the color of the brick is uniform, the hardness is increased, and the mass is brittle. The third stage, the finishing firing and vitrifying period with accompanying chemical and physical processes, is discussed. A chapter is devoted to coloring and discoloration, and the influence of reduced or oxidized firing on the color formation; the structure of the brick and the porosity and density of brick made from clays both poor and rich in lime are described. A. points out that a certain porosity increases the capacity of warmth isolation in ordinary wall brick and, to a certain extent, the stability against frost, but for face brick, only thoroughly fired brick can be used. Clays rich in lime can be used only as brick for the back part of the wall because of their great porosity and the fact that they are deformed by the vitrifying temperature; their firing is completed in the second stage. The influence of quartz or magnesium in clays on the closing of pores is discussed. The swelling of brick and its causes are treated. They are (1) remaining hydrate water, (2) residue of bituminous materials (coals), (3) incomplete oxidation in the second stage with the formation of gases, and (4) a too abrupt increase in temperature. Uncombined quartz can also influence swelling. The last part of the book is devoted to practical explanations with a model for the construction of an 18-chamber annular kiln and normal division of zones with suggestions for charging an annular kiln.

M.V.K.

Origin and Decomposition of Organic Sulphur Compounds under Gasmaking Conditions with Particular Reference to the Rôle of the Carbon-Sulphur Complex. JOHN C. HOLTZ. Johns Hopkins Univ., Baltimore, Md. 83 pp., illustrated and tables. Price $1.00. Reviewed in *Gas Age-Rec.*, **66** [9], 320 (1930).—Beginning with a historical introduction (Chapter I), H. discusses the association of carbon and sulphur in a solid product (Chapter II). A study of their compounds follows in Chapter III with the following chapter devoted to processes for the removal of organic sulphur from gas. Other subjects discussed in Part II (the experimental section) are the

carbon-sulphur complex, quantitative experiments on the hydrogen-sulphide-carbon-disulphide-carbon equilibrium, the change in organic sulphur concentration, thermodynamics of hydrogen-sulphide, etc., all of which are treated with painstaking thoroughness. A bibliography in several languages and thermodynamic computations (accompanying Chapter IX) are also appended. E.J.V.

Some Methods of Burning Continuous Kilns. ALFRED B. SEARLE. *Feuerfest*, **6** [4], 60 (1930); for abstract see *Ceram. Abs.*, **9** [2], 142 (1930). L.T.B.

Heat Technology. (Die Abwarmetechnik.) Vols. I–III. HANS BLACKE. R. Oldenbourg, Munich and Berlin, Publisher, 1929. Vol. I, 15 M; Vol. II, 11.5 M; Vol. III, 13.5 M. *Feuerfest*, **6** [6], 89 (1930).—The third volume deals with special fields in heat technology, *e.g.*, the heat evaluation in engine construction. For Vol. II see *Ceram. Abs.*, **8** [2], 156 (1930). L.T.B.

Coal Carbonization. R. WIGGINTON. *Feuerfest*, **6** [4], 60 (1930); for abstract see *Ceram. Abs.*, **9** [7], 567 (1930). L.T.B.

Technical Data on Fuel. H. M. SPIERS. 2nd ed., revised and enlarged. 242 pp., 41 figs., 149 tables. British National Committee, World Power Conference, London. Price 12s 6d, net. Reviewed in *Colliery Guardian*, **141** [3630], 327 (1930).—In this edition, the contents have been increased about one-third. Much of the new information has not hitherto been published, *e.g.*, that on pressure drop in coils, flow of fluids through beds of granular materials, creep data for alloy steels, properties of coal tars, anti-knock rating of hydrocarbons, degree of pulverization in relation to nature of fuel and conditions of use, and criterion for the presence of CO in flue gases. See also *Ceram. Abs.*, **8** [2], 836 (1929). E.J.V.

Processes of Coke Formation. (Die Vorgänge bei der Stückkoksbildung.) GEORG AGDE AND LUDWIG V. LYNCKER. Wilhelm Knapp, Halle (Saale), 1930. 48 pp. and 24 pp. of illustrations and tables. 6.40 Rm. Reviewed in *Mining and Met.*, **11** [285], 14 (1930).—An investigation of the phenomena of coking, with special reference to the structure of and composition of coke is presented. E.J.V.

Industrial heating. ANON. *Abrasive Ind.*, **11** [9], 41 (1930).—Skinner Bros. Mfg. Co., Inc., St. Louis, has issued a bulletin on the control of heat and heating costs by the use of its system and equipment in industrial and building installations. Illustrated. E.P.R.

Rotary kilns and coolers. ANON. *Pit and Quarry*, **20** [11], 80 (1930).—The Edgar Allen & Co., Ltd., Sheffield, Eng., has issued a 24-page illustrated catalogue describing rotary kilns and coolers made in the Imperial Steel Works. E.P.R.

PATENTS

Gas production. HARRY F. SMITH. U. S. 1,772,641, Aug. 12, 1930. A gas-generating system, comprising a gas producer, an offtake leading from the producer; a vent pipe opening into the offtake; a delivery main opening into the offtake; and thermostatic means responsive to heat of burning of generated gas for automatically connecting the offtake to the vent pipe or to the delivery main, according to the quality of the generated gas.

Gas producer. HARRY F. SMITH. U. S. 1,772,642, Aug. 12, 1930. In a gas-producer system, a gas-generating chamber comprising an unlined shell adapted to contain a fuel bed of solid carbonaceous material; a gas offtake positioned within the interior of the shell and adapted to be surrounded by fuel during operation; and blast means laterally spaced from the shell adapted to introduce a blast over a restricted portion of the fuel bed; the draft tube and the blast means being arranged close to each other so that the path of travel of the blast through the fuel bed will be so restricted that during gas-making operations the active zone of the fuel bed will not come into contact with the shell of the generating chamber.

Gas producer. HARRY F. SMITH. U. S. 1,772,643, Aug. 12, 1930. A gas producer comprising in combination, a stationary body portion, adapted to contain a fuel bed; a rotatable top therefor; means for rotating the top; a plurality of pokers carried by the top, means for positively reciprocating the pokers to cause these pokers to move into and out of the fuel bed, the means having structural elements whereby only one of the pokers is reciprocated at a time.

Kiln. HARRY M. ROBERTSON. U. S. 1,773,011, Aug. 12, 1930. The combination of a preheating chamber and a heating chamber, the chambers being disposed in contiguous relation to form a passage for product-bearing carriers, heating means for the heating chamber, means having connection with the passage at a point beyond the heating means and serving to induce a flow of the hot gases through the passage in the direction of movement of the carriers, and a lateral chamber formed in the wall of the passage between the heating means and the connection for the flow-inducing means.

Forming brick kilns. ARTHUR J. THERRIEN. U. S. 1,773,827, Aug. 26, 1930. The process of building an open clamp kiln which comprises placing a series of unit piles of unfired brick on the floor of the kiln with spaces substantially a brick-length in width between successive piles of the series, then sliding the brick at the top of the piles outwardly so that they extend out partially across the spaces, filling in the spaces in the top spaces of the piles made vacant by the change of position of the extended brick, and then placing a second series of unit piles of unfired brick on top of the first-named series so as to close the tops of the arches partially formed by the extending brick.

Oven of the direct-flame continuous-tunnel type. JOHN WILLIAMSON. U. S. 1,775,302, Sept. 9, 1930. In a direct-flame tunnel oven, a furnace zone for goods, having at each side thereof a number of burners and a flue, the burners being arranged to deliver the flame into the furnace zone between the side flues and the side walls of the furnace zone, the side flues being in communication with the furnace zone, and means whereby the flame is enabled to take various courses longitudinally and transversely through the goods.

Induction furnace. FRANZ LINNHOFF. U. S. 1,775,351, Sept. 9, 1930. In a coreless induction furnace, a crucible having the diameter of its upper portion larger than that of the lower portion, two inductor coils, one about each of the portions of the different diameters, a multi-phase source of current for the two coils and magnetic means between the coils for protecting each coil from magnetic interference from current in the other coil.

Tunnel kilns. WOODALL-DUCKHAM, LTD., AND A. M. DUCKHAM. Brit. 331,109, Aug. 13, 1930. In a tunnel kiln having traveling platform or trucks, there is provided at each side of the tunnel, a roller adapted to smooth out or replace by pressure any parts of the platform or trucks which, owing to expansion or other cause, project laterally beyond the normal width thereof. The rollers may be spaced apart a distance equal to the normal width of the platform or trucks, or they may be maintained in contact with the edges thereof by springs. The rollers are mounted on vertical spindles fixed in bars attached to the top and bottom plates of a casing, the latter being adjustably secured to the tunnel structure. A plurality of pairs of rollers may be provided, in which case the rollers of each pair are arranged slightly closer together than those of the preceding pair so that the removal of irregularities on the edges of the platform or trucks is effected in stages.

Tunnel kilns. H. M. ROBERTSON. Brit. 331,224, Aug. 20, 1930. In a tunnel kiln, adapted particularly for the continuous firing and glazing of ceramic goods and comprising preheating, firing, and cooling zones, salt-glazing fireplaces are located in the side walls of the kiln beyond the fireplaces which supply heat to the firing zone. The forward side wall of each fireplace is inclined.

Tunnel kilns. H. M. ROBERTSON. Brit. 331,225, Aug. 20, 1930. In a tunnel kiln comprising preheating, firing, and cooling zones, air is withdrawn from heating pipes at the sides of the cooling zone by a fan and delivered to flues which extend along the roof of the firing and preheating zones and communicate with damper-controlled delivery conduits spaced along the preheating zone.

Continuous furnace for baking porcelain. NGUYÊN-BA-CHINH. Fr. 35,952, March 15, 1928. Addition to 595,009. (*C.A.*)

Vertical chamber oven for making gas and coke. J. FOLLMAN. Ger. 485,267; *Gas Age-Rec.*, **66** [9], 339 (1930).—The chamber oven is operated for the production of both coke and semicoke. It is provided with vertical heating flues and both upper- and underfiring. Regenerators are located on the narrow side of the oven for the preheating of the gas and air. Each two neighboring heating walls are connected by means of lateral connecting flues which run around the oven chambers. Thus the even and uneven numbered heating flues of a heating wall are connected with the corresponding flues of a neighboring heating wall by an upper and lower encircling conduit, shaped in the form of a horseshoe. Two independent groups are thus formed, one of them heated from the bottom, and the other from the top in the same heating wall, at the same time. This is accomplished in such a manner that the even-numbered heating flues of each wall are connected at their lower ends with pairs of regenerators belonging to one side of the oven; the uneven numbered flues of each heating wall are connected at their upper ends with pairs of regenerators on the other side of the oven. E.J.V.

Retort oven for carbonization of fuels. INTERNATIONAL HOLDING DE DISTILLATION ET COKEFACTION À BASSE TEMPÉRATURE ET MINIÈRE (HOLCOBAMI) SOCIÉTÉ ANON. Ger. 486,175; *Gas Age-Rec.*, **66** [9], 339 (1930).—In the carbonizing oven each of the chambers which contain the retorts is provided with a forechamber in which the flue gas is ignited. The burning gases then enter the retort chambers and flow through chambers which are first in series to the forechamber, as well as the remaining ones. E.J.V.

Gas producer without a grate. A. GWOZDIK. Ger. 487,349; *Gas Age-Rec.*, **66** [9], 339 (1930).—In place of the usual grate, this gas producer is provided with a number of hollow rods which are arranged in different ways, *i.e.*, they may be arranged parallel to one another, in the form of a triangle, or in the form of a star. The rods serve for the introduction of combustion air into the fuel bed which is located underneath these rods on an automatic clinkering device. E.J.V.

Annular chamber oven for ceramic goods. BORNKESSEL & CO.M.B.H. Ger. 498,405, April 21, 1927. (*C.A.*)

Mechanical stoker for annular kilns. ARMAND TRANZER. Ger. 499,406, April 24, 1928. (*C.A.*)

Geology

Structure of sodalite and helvite. L. PAULING. *Z. Krist.*, **74** [2], 213–25 (1930).—Using data from rotation and Laue photographs, it is shown that the unit structure of sodalite contains two molecules. $a_0 = 8.87$Å. The lattice is simple cubic, Γc; the structure closely approximates one based on a body-centered lattice. The atomic arrangement has 2Cl in 2*a*; 8Na in 8*a*, parameter *u*; 6Si in 6*f*; 6Al in 6*y*; 240 in *x*,*y*,*z*. The comparison of absorbed intensities of reflection in 8 orders from (110) and intensities calculated for a range of parameter values suggested by assumed minimum interionic distances led to the values $u = 0.175$, $x = 0.135$, $y = 0.440$, and $z = 0.150$. These values were verified by a large number of other reflections. Helvite

was found to have a unit of structure with $a_0 = 8.25$Å, containing 2 molecules. The structure is similar to that of sodalite, the parameters having the values $u = 0.175$, $x = 0.113$, $y = 0.416$, and $z = 0.137$. Both structures satisfy the electrostatic valence rule. G.R.S.

Structure of analcite ($NaAlSi_2O_6 \cdot H_2O$). W. H. TAYLOR. *Z. Krist.*, **74** [1], 1–19 (1930).—Because of its definite chemical composition, analcite is suitable for an attack on zeolite structures. The cubic unit cell with edge 13.7Å contains 16 molecules, and the space group is O_h^{10}. Diagrams show the two kinds of rings, one of 4 and the other of 6 tetrahedra, from which analcite structure is built. Photographs are given of the unit cell, showing how the tetrahedron rings are linked together. G.R.S.

Alpine beryllium deposits. A. TORNQUIST. *Metall Erz*, **27** [14], 362–65 (1930).—The geology and petrography of the Kreuzberg pegmatites in which T. claims beryl occurs are given. L.T.B.

Be-content of the supposed "beryl" deposits of Kofiach in Steiermark. A. CISSARZ, H. SCHNEIDERHOHN, AND E. ZINTL. *Metall Erz*, **27** [14], 365–66 (1930).—No trace of Be was found in rocks similar to those which were reported to contain that element by Tornquist, *et al.* Chemical and spectroscopic methods were used to try to identify this element. L.T.B.

Porosity of diatomite. G. DALLAS HANNA. *Eng. Mining Jour.*, **130** [1], 7–8 (1930).—An illustrated discussion of the cause of the low density of diatomite is given. E.C.C.

Double refraction of bentonite. R. BRADFIELD AND H. ZOCHER. *Kolloid-Z.*, **47**, 223 (1929); *Sprechsaal*, **63** [35], 664 (1930).—The double refraction of a flowing suspension of natural bentonite when observed with a polariscope or polarizing microscope is found to be negative in contrast to the "flow" double refraction of a suspension of Thüringian clay. After subjection to electrodialysis, the bentonite shows positive-flow double refraction. Apparently the sign change by electrodialysis depends upon an alteration of the inner constitution of the anisotropic colloid particles which lose their bases through dialysis. The constitution of these crystals is analogous to the zeolite crystals, both of which show capacity for base exchange. H.I.

Flow-double refraction and thixotropy of bentonite suspensions. A. VON BUZAGH. *Kolloid-Z.*, **47**, 223–29 (1929); *Sprechsaal*, **63** [35], 664 (1930).—A bentonite freed from coarse-grained material was separated into two parts by peptization with water. The easily peptizable portion contained much less alkalis and alkaline earths than the difficultly peptizable portion. The two portions were distinguishable by the flow-double refraction of their suspensions, the easily peptizable, alkali-poor portion showing positive double refraction and the other portion, negative double refraction. By removal of the electrolytes by electrodialysis, a positive doubly refracting suspension was obtained from the negative doubly refracting suspension of the bentonite. By addition of alkali to an electrodialyzed bentonite the positive double refraction was increased; by the addition of calcium hydroxide a weakly-negative doubly refracting suspension was produced. The original bentonite with water in suitable proportions gave mixed thixotropic pastes whose setting times decreased markedly with increased bentonite concentrations. The electrodialyzed bentonite gave thixotropic pastes with dilute alkali-hydroxide solutions but not with water. The same is true for kaolin which only shows thixotropy in the presence of alkalis. H.I.

Structure of melilite $(Ca, Na)_2(Mg, Al)(Si, Al)_2O_7$. B. E. WARREN. *Z. Krist.*, **74** [2], 131–38 (1930).—Mellite is tetragonal, with $c = 0.4548$. From rotation photographs it is found that the unit cell has the dimensions $a = 7.73$Å, $c = 5.01$Å, and contains 2 molecules. The "a" axis of the true unit cell is at 45° to that used in Dana. A Laue pattern parallel to 001 showed the full symmetry of D_{4h}. From a number of

15° oscillation photographs, it was found that planes of all types reflected with the exception of the odd orders of (100). The space group is either D_4^2 or D_{2d}^3 and by trial it was found impossible to build a reasonable structure with D_4^2. The completed structure involves 10 parameters, and these have been determined by means of qualitative intensity estimates from oscillation photographs. Each silicon is surrounded by four oxygen in a tetrahedral arrangement. These tetrahedral groups occur in pairs sharing one oxygen between them, and forming Si_2O_7 groups. (Mg, Al) has a combination number 4, and that of calcium is 8. G.R.S.

Meliphanite and leucophanite. W. H. ZACHARIASEN. *Z. Krist.*, **74** [2], 226–29 (1930).—The minerals, meliphanite and leucophanite, have analogous formulas which are, respectively, $(Ca,Na)_2Be(Si,Al)_2(O,F)_7$ and $(Ca,Na)_2BeSi_2(O,OH,F)_7$. It is very probable that meliphanite (together with the mineral Hardystonite $Ca_2ZnSi_2O_7$) has the melilite structure recently determined by B. E. Warren (see preceding abstract); leucophanite, on the other hand, has a deformed melilite structure. G.R.S.

Exchange reactions of water-insoluble alkaline-earth phosphates with permutites and clays. E. UNGERER. *Kolloid-Z.*, **48,** 237–41 (1929).—The tertiary phosphates $Mg_3(PO_4)_2 \cdot 22H_2O$, $MgNH_4PO_4 \cdot 6H_2O$, and $Ca_3(PO_4)_2$ were shaken with water and a potassium permutite. After filtration the phosphoric acid and the potassium in the filtrate were determined analytically. In general, the water-soluble phosphoric acid and the amount of potassium removed from the permutite increased with increasing concentration of permutite. A clay which had been digested for several weeks with KCl solution and from which the bivalent bases had afterward been washed showed the same phenomena as the permutite when treated with the alkaline-earth phosphates. The reaction has importance in the conversion of difficultly soluble phosphates in soils. H.I.

Cataphoresis migration velocity of zeolite suspensions. A. VON BUZAGH. *Kolloid-Z.*, **49,** 35–39 (1929).—A chabazite which contained 2.24% potassium and 9.78% calcium was powdered, treated with calcium chloride solution to remove the potassium by base exchange, and electrodialyzed to remove the calcium. Analysis of the treated product showed a nearly pure alumino-silicate. A synthetic alumino-silicate was prepared by treating a 2% sodium-silicate solution with an aluminium-chloride solution, washing the precipitate formed, suspending in water, and electrodialyzing. The cataphoresis migration velocity of the two silicates in the presence of electrolytes was measured. In small concentrations the alkali hydroxides raise, and in large concentrations lower the electrokinetic potential. In all concentrations, calcium and barium hydroxides had only a depressing effect on the potential. The chlorides of monovalent and bivalent cations show a discharging effect in the following series: $NaCl > KCl > CaCl_2 > BaCl_2$. Aluminium and thorium chlorides act as dischargers in small concentrations, effect a reversal of sign in greater concentrations, and act as dischargers again in the positively charged region. B. concludes that an electrodialyzed zeolite suspension behaves as other suspended materials which have a negative character in water. H.I.

Lime-silica reactions in soils. W. M. SHAW. *Jour. Assn. Official Agric. Chemists,* **13,** 164 (1930).—The system $CaO–SiO_2–H_2O$ was investigated as part of a major study of the soil's components that react with aqueous $Ca(OH)_2–CaSO_4$ solutions. H.H.S.

Graphical presentation of rock analyses. W. F. GISOLF. *Tschermak's mineral. petrog. Mitt.*, **39,** 76–82 (1928).—Some modifications of the graphic method of Niggli are suggested. (*C.A.*)

Chemistry of the feldspars. D. BELIANKIN. *Bull. acad. sci. U. S. S. R., Classe sci. phys.-math.*, pp. 571–84 (1929).—Although of secondary importance, Fe deserves a place in the petrography and classification of the feldspars. In a few cases, such as albite from Kirjabinsk and oligoclase from Murmansk (Mount Medvedka), Fe is not

present in a form detectable by ordinary analytical methods, but most feldspars contain it in amounts up to 2 to 3%. Ba is commonly present in K-Na feldspars, although mostly absent from plagioclases. Rocks of similar petrographic character, and not only belonging to the same region but apparently derived from the same magma, sometimes contain feldspars of widely different Ba content; thus, laurvikite from S. Norway contains 0.35% BaO, whereas anorthose of the same origin is free from Ba. Similarly, miaskites from the Ilmen mountains normally contain Ba, which is not found in syenites from these mountains. Sr is usually present in feldspars in minimum proportion. The chemical formulas of the feldspars are discussed, as well as the distribution in the space lattice of the excess oxides. Results are given of a number of analyses of K-Na feldspars and plagioclases of various origins. The analytical data in certain cases seem inexplicable except by assuming the existence of chemical anomalies. (*C.A.*)

Chemistry of igneous rocks. Chemical equilibria in cooling rock magmas as depending on the constitution of the silicates. I. WALTER WAHL. *Fennia* (*Bull. Soc. Géog. Finlande*), **50** [29], 32 pp. (1928); *Mineralog. Abs.*, **4**, 126.—Simple aluminosilicates in which Al shows the coördination No. 4, simple orthosilicates, aluminates, Fe oxides, and SiO_2 are stable at high temperatures. With falling temperature, metasilicates and Al compounds with the coördination No. 6 form, while addition reactions produce the amphiboles, micas, and members of the sodalite group, and subsequently minerals of the melilite and garnet groups and analcite. H_2O vapor then plays a part giving epidote, chlorite, scapolite, and finally zeolites and calcite. The essential reaction is the conversion of 4-coördinate Al minerals into 6-coördinate ones as the temperature falls. For Part II see *Ceram. Abs.*, **9** [6], 473 (1930). (*C.A.*)

Apatites, their chemical composition and its relation to their physical and morphological properties. H. HAUSEN. *Acta Acad. Aboensis Math. Phys.*, **5** [3], 1–62; *Chem. Zentr.*, **i**, 2866 (1929).—Using the material published in the literature as the basis, the relation of chemical composition of the apatites to the physical and morphological properties is explained. (*C.A.*)

Application of geophysics in mining. H. SHAW. *Queensland Govt. Mining Jour.*, **31** [7], 283–84 (1930).—A short account of methods applicable to geological and mining problems is given. The use of geophysical methods is not intended to supersede existing geological methods for prospecting, but is to be considered as an additional means to assist the mining engineer to locate mineral deposits and to enable geologists to ascertain subterranean structure. E.P.R.

Mineralogy of deposits of kaolinized volcanic ash from the Slate Belt of North Carolina. J. L. STUCKEY. *Amer. Mineralogist*, **15** [7], 253–58 (1930).—Beds of white to gray clay, commonly called kaolin, occur in the Slate Belt of N. C. They are lenticular in shape, irregular in size, and are made up of deposits having a soft, smooth feel, but become gritty in some places. Seven samples for this study were collected from deposits on Drowing Creek in Moore and Montgomery counties, and one each from Randolph and Granville counties. Screen tests, microscopic examinations, and chemical analyses were made. Field evidence shows that the three deposits described lie in the area of acid volcanic rocks. Two of the samples have many characteristics of a fine tuff or volcanic ash. The other five, due to weathering, show little resemblance microscopically to true fragmental materials. The general similarity of all the materials and their association with acid volcanic rocks indicate that they were originally fine-grained tuff or volcanic ash. In the northern part of the Slate Belt where metamorphism has been severe, the fine-grained materials doubtless have been changed directly to sericite schist, while further south where dynamic forces were less intense they have weathered to impure kaolin. G.R.S.

Feldspars in the Adirondack anorthosite. H. L. ALLING. *Amer. Mineralogist*, **15** [7], 267–71 (1930).—A. takes exception to the conclusions reached by Barth in his paper "Mineralogy of the Adirondack Feldspars" (see *Ceram. Abs.*, **9** [6], 468 (1930)). A review of the literature together with a discussion of the points made by B. is given. A. does not agree that andesine-labradorite is potash free, nor that late-stage feldspar is potash-free oligoclase and a comparatively pure potash feldspar. Neither has potash feldspar a true melting point, but melts incongruently. A. concludes that (1) the plagioclase of the Adirondack anorthosites consists of labradorite grading into andesine with an appreciable though small percentage of potash feldspar in solid solution and (2) late stage interstitial feldspars are soda-rich anorthoclases and potash-bearing oligo-clases. The latter may be untwinned. G.R.S.

Technological aspects of the soapstone mining industry in Virginia. C. W. RYAN. *Pit and Quarry*, **20** [10], 60–64 (1930).—This paper contains a brief sketch of the geology of soapstone in the Piedmont section of Va., also a description of methods of prospecting, developing quarries, quarrying, and milling methods in that section. E.P.R.

Diatomite from central Oregon deposit. W. A. SCOTT. *Pit and Quarry*, **20** [10], 57–59 (1930).—The well-known diatomite property situated on the Deschutes River, seven miles from Terrebonne, Ore., was owned formerly by the Diatomite Co., controlled by J. W. Ganong. In 1927, it was acquired by the Atomite Corp. of Portland, Ore. Since then the property has been developed and operated by A. Krieger, president and managing director. E.P.R.

Deposits of kaolin in Idaho. ANON. *Brick Clay Rec.*, **77** [4], 222 (1930).—Large deposits of kaolin, extending at least 30 ft. down, have been located about two miles north of Moscow, Idaho, and a first shipment of the clay has been made. E.J.V.

Fullers' earth deposit discovered in Montana. ANON. *Pit and Quarry*, **20** [11], 27 (1930).—An immense deposit of fullers' earth at a point 21 miles northeast of Anaconda is reported by the Lincoln Mining Co. Assays of the mineral run 98% pure and the veins converge 200 ft. below the surface to form a mountain of solid fullers' earth now known as Mud Mountain. E.P.R.

Bavaria principal source of fullers' earth in Europe. ANON. *Pit and Quarry*, **20** [10], 35 (1930).—The principal supply of fullers' earth in Europe comes from the important occurrences of crude fullers' earth in Bavaria. The so-called Tonsil group, composed of Tonwerk Moosberg, A. M. Ostenrieder G.m.b.H., and Tonsilwerken G.m.b.H. has joined with Siriuswerke A.G., in a rationalization program. The new group controls most of the fullers' earth in Europe, has opened a joint office in Munich, and is said to be associated with Dutch capital. E.P.R.

Nonmetallic minerals important factor in Canada's future development. M. F. GOUDGE. *Pit and Quarry*, **20** [10], 46–48 (1930).—Nonmetallic minerals are indispensable to most manufacturing industries. Canada has a variety and abundance of nonmetallic resources, which include most of the more widely used minerals, bauxite being a notable exception, and a great number of the more uncommon minerals such as lithium minerals, actinolite, and uraninite. These resources are well distributed, with respect both to the present centers of population and to the needs of the future. In 1929, the total mineral production of Canada, according to the official estimate of the Dominion Bureau of Statistics on March 1, 1930, was valued at $307,146,494, to which the nonmetallic contributed $153,452,191, or slightly under 50%. E.P.R.

Fire clays of southern Saskatchewan. G. M. HUTT. *Can. Mining Jour.*, **51**, 493–94, 525–26 (1930); for abstract see *Ceram. Abs.*, **9** [10], 878 (1930). (*C.A.*)

Modern German limestone quarrying plant. P. LUDOWIGS. *Rock Prod.*, **33** [17], 91 (1930); for abstract see *Ceram. Abs.*, **9** [9], 799 (1930). W.W.M.

English kaolin: a quality product. E. H. DAVISON. *Times Eng. Supp.*, **26** [620],

53 (1930).—Map, photograph of clay pit, and statistical tables of prices, export tonnage, and destinations are given. H.H.S.

BOOKS AND REPORTS

Diatomaceous Earth. ROBERT CALVERT. *Jour. West. Soc. Eng.*, **35** [4], 298 (1930); see also *Ceram. Abs.*, **9** [7], 575 (1930). W.W.M.

Investigations of Mineral Resources and the Mining Industry, 1928. ANON. Dept. Mines, Mines Branch, *Rept.*, No. 710; *Can. Chem. Met.*, **14** [8], 48 (1930).—This report contains (1) A preliminary report on limestones of northern and western Ontario and the Prairie Provinces, by M. F. Goudge; (2) Potash salts in the Maritime Provinces, by L. H. Cole; (3) Core-drilling bituminous sands of Northern Alberta, by S. C. Ells; and (4) Preliminary report on molding sands in Eastern Canada, by C. H. Freeman. E.J.V.

Mining of Alluvial Deposits by Dredging and Hydraulicking. W. E. THORNE AND A. W. HOOKE. Mining Publications, Ltd., London. Price 20s, net. Reviewed in *Engineering*, **130** [3370], 195 (1930). A.A.

Clays of Louisiana (Alexandria Area). J. W. WHITTEMORE. Dept. of Conservation, State of Louisiana. 277 pp. A continuation of the work already done in other areas. (*S.S.*)

Mineral Composition of Some Sands from Quebec, Labrador, and Greenland. J. H. C. MARTENS. Field Museum of Natural History, *Pub.*, No. 260, 34 pp. (1929); *Jour. West. Soc. Eng.*, **35** [3], 227–28 (1930); for abstract see *Ceram. Abs.*, **8** [11], 841 (1930). W.W.M.

Dolomites of Western Oklahoma. G. G. SUFFEL. Okla. Geol. Surv., *Bull.*, No. 49, 155 pp. (1930).—Dolomites occur in a narrow belt extending southwesterly from Kansas to Washita, Caddo, and Canadian counties; also in southwestern counties. The physiography and geology of the region are described and some analyses are given. (*C.A.*)

Chemistry and Physics

X-ray examination of the effect of heat on aluminium hydroxide $Al_2O_3 \cdot 3H_2O$. H. P. ROOKSBY. *Trans. Ceram. Soc.* [Eng.], **28** [10], 399–413 (1929).—The composition of precipitated aluminium hydroxide and the changes occurring when crystalline $Al_2O_3 \cdot 3H_2O$ is heated were studied by the X-ray powder method, using CuK α radiation. A number of the X-ray patterns obtained are reproduced, and a table comprising the calculated spacings of the patterns is also given. The crystalline hydrate of alumina prepared from sodium aluminate has the composition $Al_2O_3 \cdot 3H_2O$. Alumina precipitated from an aluminium chloride solution with ammonium hydroxide varies in composition according to the conditions of precipitation, but consists of mixtures in various proportions of two definite hydrates, $Al_2O_3 \cdot 3H_2O$ and $Al_2O_3 \cdot H_2O$. In most cases the latter hydrate is in excess. Crystalline $Al_2O_3 \cdot 3H_2O$ loses water when heated to 200°C and on heating to 250°C a definite hydrate $Al_2O_3 \cdot H_2O$ is formed, its X-ray pattern being different from that of diaspore but the same as those of certain bauxites. Between 250°C and 500°C the hydrate $Al_2O_3 \cdot H_2O$ loses water with formation of γ-alumina. At 950°C, the γ-alumina X-ray pattern consists of sharp lines, crystal growth taking place between 500°C and 950°C. At 1000°C, γ-alumina begins to change to corundum and at 1150°C, the change is complete. See also *Ceram. Abs.*, **9** [4], 310 (1930). R.F.S.

Titrometric determination of magnesium. J. ST. PIERCE AND M. B. GEIGER. *Ind. Eng. Chem., Anal. Ed.*, **2**, 193 (1930); *Sprechsaal*, **63** [30], 565 (1930).—The method hitherto suggested for the titrometric determination of magnesium in the

presence of calcium compounds has disadvantages which increase the errors of analyses. With the following method these disadvantages are avoided. This method depends on the precipitation of MgO as $Mg(OH)_2$ with a CO_2 standard solution free from alkalis. When the transition point is attained by the titration with trinitrobenzene as indicator, CaO remains in solution. But a surplus of alkalis is needed here which must be determined by titration with acid after the precipitation of MgO. The final point of titration lies near $p_H = 4$. Five-tenths g. of the analysis substance are dissolved in 50 cc. of 0.25 normal HCl. The CO_2 is driven away by boiling, 5 to 6 drops of an 0.04% alcoholic solution of thymol blue bromide are added, and the solution is neutralized with alkalis till a blue color appears. Then it must be filtered and washed from the sediment. The filtrate and wash water are mixed with 5 drops of 0.1% alcoholic solution of dimethylaminoazobenzene and titrated with 0.25% normal HCl till the appearance of a pink-red color. Then 10 cc. of a saturated alcoholic solution of trinitrobenzene are added and titrated with 0.25 normal CO_2 free from soda lye (B_1) till the appearance of a deep red color. The solution is transferred in a 100-cc. measuring flask and the titration continued, if necessary, to maintain the red color. The solution is then filled up to 100 cc., and filtered off by a dry filter from the precipitated $Mg(OH)_2$. The funnel must always be covered with a watch glass. Fifty cc. of the filtrate are then titrated back with an indicator with a color change of about $p_H = 4$ and which can be recognized in a red colored solution (bromphenol blue or Congo red), and 0.25 normal HCl (A_1). The content of MgO in % is given by the equation: $B_1 - 2A_1 = \%$ MgO. Instead of filtering, the solution can be centrifuged after the precipitation of $Mg(OH)_2$ and one part of the solution transferred with a pipette till the end of the titration.

M.V.K.

Quick method for determining alkalis in glass. H. RITTER. *Sprechsaal*, **63** [27], 506–507 (1930).—R. describes the method of Berzelius for the determination of alkalis in glass, noting the disadvantage that alkali chlorides are exceptionally volatile even when carefully heated to redness and, therefore, can be brought to constant weight only with extreme caution; also that the alkalis are generally present as sulphates and must be changed into chlorides because potassium is precipitated quantitatively only from chlorides. The determination of potassium by this method is both awkward and lengthy. The determination of alkalis as sulphates ($Na_2SO_4 + K_2SO_4$) is much simpler. These are much less volatile and are more easily brought to constant weight. Investigations showed that the separation of sodium from potassium by precipitation of sodium is possible and it makes no difference whether the alkalis are present as chlorides or sulphates. After the total alkali determination, the residue on ignition is again dissolved, the reagent added to it, and the sodium is precipitated quantitatively as a triple salt $(UO_2)_3ZnNa(CH_3COO)_9 + 6H_2O$. The determination of sodium with the help of the triple salt can also be used when sodium is greatly in excess of the alkalis, and only a small quantity of potassium is present, which is frequently the case in glasses. Two solutions for the precipitating reagent are prepared: (1) 10 g. uranyl acetate ($2H_2O$), 6 g. 30% acetic acid, 65 g. water; (2) 30 g. zinc acetate ($3H_2O$), 3 g. 30% acetic acid, 65 g. water. The two solutions are mixed, and after standing 24 hrs. in case a small sediment is formed, again filtered. The whole process of determining sodium is described. An analysis table is given.

M.V.K.

Densities of molten sodium and potassium. M. E. RINCK. *Compt. rend.*, **189** [1], 39–41 (1929).—In 1914, Lorentz and Van Laer proposed a new law of mass action applying to condensed heterogeneous systems, *e.g.*, $Na + KCl \rightleftharpoons K + NaCl$. Use of the law requires knowledge of the atomic volumes of all the constituents at the equilibrium temperature. R. determines the densities of Na and K hydrostatically by weighing a piece of copper suspended in the molten metal. The molten metal was contained

in a nickel tube placed in a large block of aluminum and heated electrically to temperatures constant to less than 0.1°C. The densities were measured at intervals from 325 to 595.5°C for K and 429 to 639.5° for Na resulting in the following equations: (1) d_{Na} 0.9835−0.000260 (t−96.5), and (2) d_K 0.826−0.000222 (t−62.4), which are accurate enough for extrapolation to 900°C. R.H.E.

Rarer constituents of clays. A. FIOLETOV. *Keram. Rund.*, **37**, 659–63(1929).—Continuing the work described in a previous paper, F. analyzes clays from various parts of Russia for TiO_2, V_2O_5, and ZrO_2. Among others are clays from the Moscow coal fields. The analysis for TiO_2 was made colorimetrically with U_2O_3, for V_2O_5 by titration with N/100 $KMnO_4$, and for ZrO_2 as $Zr_2P_2O_7$. Analyses showed a maximum of 2.15% TiO_2 as rutile or ilmenite, 0.166% V_2O_5 as sulphide, and 0.10% ZrO_2 as zircon. Clays in contact with coal showed higher V-content consistently. This is accounted for by postulating that the vanadium sulphide is formed by reaction with organic sulphur compounds at the contact zone. None of these impurities would vitiate the use of these clays as ceramic materials. See also *Ceram. Abs.*, **8** [10], 769 (1929). H.I.

General (exact) equation to the potentiometric-titration curve. BERNARD CAVANAUGH. *Jour. Chem. Soc.*, pp. 1425–47 (June, 1930). E.C.C.

Determination of heat-transmission coefficients by diffusion experiments. W. LOHRISCH. *Forschungsarbeiten*, **322**, pp. 46–68; *Mech. World*, **88** [2275], 124 (1930).—L. states that the "temperature coefficient of the fluid $a = \frac{\lambda}{C_p \gamma}$, where λ = heat-conductivity coefficient of air, C_p = specific heat at constant pressure, and γ = specific weight, and is of similar dimensions to the diffusion coefficient, K. Graphs illustrating the heat-transmission coefficients as functions of the air velocity are given from which the following relationships are derived: For stationary tubes $a = C_1 \frac{\lambda}{d} \cdot f\left(\frac{wdp}{\mu}\right)$; for rotating tubes $a = C_2 \frac{\lambda}{d} \cdot f\left(\frac{wdp}{\mu} \cdot \frac{udp}{\mu}\right)$; μ = viscosity of air, d = tube diameter, w = air velocity, u = peripheral velocity of rotating tube, p = mass density of air, and C_1 and C_2 are determined experimentally. E.P.R.

Explosion of detonating gas at low pressures by warm quartz. HUBERT N. ALYEA AND F. HABER. *Naturwissenschaften*, **18** [20], 441–43 (1930).—Detonating gas if contained in quartz vessels explodes immediately when raised to temperatures of about 500°C, provided the pressure varies between 3 and 78 mm. mercury. At higher pressures there follows only a slow reaction. The explosion is due to a reaction originating at the surface of the vessel. L.T.B.

Solubility of zirconium and hafnium halogenides. G. v. HEVESY AND O. H. WAGNER. *Z. anorg. allgem. Chem.*, **191** [3], 194–200 (1930).—Solubility measurements of the oxychlorides of these metals in HCl and HBr are given. L.T.B.

Chlorination of oxides and of the mixtures of these oxides with carbon. VICTOR SPITZIN. *Z. anorg. allgem. Chem.*, **189** [4], 337–66 (1930).—A series of studies is given on the behavior of the oxides of Be, Al, Si, and Fe in chlorine and in hydrochloric acid at various temperatures, and also the behavior of these oxides when carbon is present. Fe and Be oxides react only slightly with HCl at room temperatures to form a chloride and a hydrate of the metal. In the case of BeO this reaction ceases at 140°C, due to hydrolysis of the hydrate. At 600°C, HCl again begins to react with BeO, at 800°C, with Al_2O_3, and at 1000°C, with SiO_2. Fe_2O_3 begins to react with Cl at 400°C, with BeO at 600°C, with Al_2O_3 at 800°C, and with SiO_2 at 1200°C. In the presence of carbon the temperature of the beginning of the reaction is the same but it proceeds more rapidly than when carbon is absent. L.T.B.

Applied spectroscopy. FRITZ LOEWE. *Oesterr. Chem.-Ztg.*, **33** [15], 125–27 (1930).—L. outlines the spectroscopic method for the qualitative and quantitative determination of small amounts of elements in minerals, salts, and other substances. The method may be used as a control in the refining of metals such as platinum, gold, etc. Qualitatively, the method is sensitive; a good quantitative estimate of the amount of an element may be obtained. It cannot be used for the detection of Cl, Br, I, O, N, S, and Se. L.T.B.

Refractive index in chemical analysis. (Refractometer and interferometer methods.) FRITZ LOEWE. *Oesterr. Chem.-Ztg.*, **33** [14], 116–17 (1930).—An account of the application of the methods in chemical analysis is given. The refractometric method may be used for qualitative and quantitative analysis of materials. It is used in identifying semiprecious minerals and glass. It may also be used for the determination of the constituents of a liquid, *e.g.*, alcohol in water, etc. The analysis is accurate and rapid. The interferometer method is extremely accurate. It may be used for gas analysis, for the analysis of the salt content of water, titration of dilute solutions (to 0.001 normal), etc. By these methods only a very small amount of sample is required. L.T.B.

Constitution of the polyborates. EGON WIBERG. *Z. anorg. allgem. Chem.*, **191** [1], 43–48 (1930).—A series of structural formulas are given for the borates of the general type $H_{n-2}B_nO_{2n-1}$. L.T.B.

Silica gel. KURT VON LUDE. *Oesterr. Chem.-Ztg.*, **33** [13], 108–10 (1930).—A review of the properties and industrial uses of silica gel is presented. L.T.B.

Tests on the borates of the system Na_2O–B_2O_3–H_2O at 45°. U. SBORGI AND L. AMELOTTI. *Gaz. Chim. Ital.*, **60** [6], 468–74 (1930).—A diagram and tables give the results obtained. M.V.K.

Action of aqueous hydrofluoric acid on silica. WILLIAM GEORGE PALMER. *Jour. Chem. Soc.*, pp. 1656–64 (July, 1930).—The rate of reaction of dilute hydrofluoric acid on fused silica has been determined and shown to be unrestricted by any diffusion process at the surface of the solid. It is not primarily dependent on the concentration of the free hydrofluoric acid, but is proportional to that of the HF_2 ion when the reaction occurs in the presence of a large ionic concentration. When the latter is low the rate is given by the expression: rate = K (total ionic concentration × CHF_2). Some of the data obtained suggest a specific catalysis by the hydrogen ion, but this possibility has not been closely examined. E.C.C.

Physics brought up to date. SAUL DUSHMAN. *Gen. Elec. Rev.*, **33** [327], 335 (1930).—In certain phenomena, discovered only within the past three years, matter behaves as if it were constituted of waves. De Broglie theorized that there is associated with corpuscles in motion a "wave-length," the magnitude of which varies inversely as the momentum. This is the basis of "quantum mechanics." H.H.S.

Calculation of ceramic bodies, glazes, enamels, and glasses in practice. W. LOKSCHIN. *Keram. Rund.*, **38**, 69–71, 110–12, 154–59, 204–206, 239–41 (1930).—Elementary rules for calculating the batch composition and the finished composition both in weight % and in molecular formulas are given. The oxide constants of Winklemann and Schott and of Mayer and Havas for calculating the expansion coefficients, and those of Vielhaber for calculating the fusibility of glasses and enamels, are reviewed. H.I.

System lime–alumina–silica. E. BERL AND F. LÖBLEIN. *Arch. Wärmewirt.*, **10**, 339–42 (1929); *Chem. Zentr.*, **i**, 574 (1930); see also *Ceram. Abs.*, **9** [9], 749 (1930). (*B.C.A.*)

Crystal structure of benitoite, $BaTiSi_3O_9$. W. H. ZACHARIASEN. *Z. Krist.*, **74** [2], 139–46 (1930).—Benitoite crystallizes ditrigonal-bipyramidal. The unit cell con-

tains 2 molecules, and has the dimensions $a = 6.60$Å, $c = 9.74$Å, and $c/a = 1.4712 = 2 \times 0.7356$. The space group is D^3_{3h}. Calculated density is 3.73. The Laue oscillation and ionization methods were used. The structure is given in the following information: 2Ba in positions $2e(\frac{2}{3}\ \frac{1}{3}\ 0)$; 2Ti in positions $2c(\frac{1}{3}\ \frac{2}{3}\ 0)$; 6Si in $6k(u_1v_1\frac{1}{4})$, $u_1 = 80°$, $v_1 = -20°$; $6O_I$ in $6k(u_2v_2\frac{1}{4})$, $u_2 = 80°$, $v_2 = 70°$; $12O_{II}$ in 12 $1(xyz)$, $x = 125°$, $y = -30°$, $z = 42°$. Si is surrounded by $2O_I + O_{II}$ forming a nearly regular tetrahedron: $Si - O_I = 1.65$Å, $Si - O_{II} = 1.59$Å. The silicon tetrahedra, grouped 3 together, form rings of composition Si_3O_9. Ti is surrounded by $6O_{II}$ in an almost regular octahedron, the distance Ti-O being 1.96Å. Ba is surrounded by 6O at a distance of 2.74Å. The 6O around Ba form a distorted octahedron. The empirical rules of a complex coordination structure are satisfied. G.R.S.

Crystal chemistry of alumino-silicates. Relation of the anorthite group to the nepheline group. W. EITEL, E. HERLINGER, AND G. TROMEL. *Naturwissenschaften*, **18** [20], 469–74 (1930).—The purpose of the work was to determine the relation of anorthite to nepheline. This was done by substituting in both members other atoms for the Al atom. These substituted atoms had to have three positive ionic charges. Among such atoms are the rare earths, especially gallium and scandium. Comparison of the X-ray patterns of the two original minerals showed that there could be no isomorphism between them. All of those minerals with rare earths substituted for Al had a similar X-ray structure, which resembled that of kaliophilite rather than that of nepheline or anorthite. Optical properties of these rare-earth anorthites and nephelines are given. No solid solutions were found between the rare-earth minerals and those containing Al, but there was solid solution between certain of the rare-earth minerals. There seemed to be some evidence of a base exchange of the alkalis for the rare earths. A theoretical discussion and explanation of some fundamental principles underlying the structure of these minerals follows. The conclusion is that there is a crystallographic relation between nepheline and anorthite, but no isomorphism. L.T.B.

Reactions in solid state at high temperatures. Effect of gases on reactions in solid state. WILHELM JANDER AND W. STAMM. *Z. anorg. allgem. Chem.*, 190 [1], 65–78 (1930).—Studies on the rate of reaction of $BaCO_3$ and $CaCO_3$ with SiO_2, and also of CaO with quartz in dry air and in atmospheres containing water vapor, H_2 and NH_3 are presented. The degree of reaction was measured by determining the CO_2 or quartz remaining at the conclusion of the experiment. The presence of water vapor increased the rate of reaction in all of these systems; and the greater the amount of H_2O present the more complete the reaction. The effect of H_2 and of NH_3 could not be studied satisfactorily because H_2O was formed to complicate the system. The mechanism of this effect of water vapor was explained as follows: In the reactions, two crystals of the two components lie side by side and react to form a thin layer of the binary compound. There must be a diffusion of the remainder of the original materials through this new product for the reaction to proceed. The effect that the water vapor has on this process is not due to a chemical reaction such as hydration since no water is found in the product. It may be due to a solution of small amounts of water in the crystals. Such solution is recognized in the case of quartz. The solution of water may cause the expansion of the crystal lattice, thereby decreasing the electrostatic adhesive forces. This loosening of the lattice may then increase permeability so that the reaction can proceed. Or the water may cause this increase in rate of reaction thus: measurement of the electric conductivity and diffusion coefficient shows that at the surface of crystals diffusion is greater than in the interior. The presence of water vapor may cause a finer grained product to form than in its absence, and hence a greater surface. This is not so strange if we remember that finer-grained materials crystallize from a melt which has traces of impurities which are not taken up in solid solution by the product than crystallize in the

absence of such impurities. In such melts there is greater surface and therefore greater reactivity. L.T.B.

Silicon, aluminum, and iron in the change of weathering processes. H. HARRASSOWITZ. *Z. angew. Chem.*, **43** [9], 185–90 (1930).—Soil, a reaction product formed from the deeper lying mother rocks, represents a heterogeneous system of many phases and components, a study of which is extremely complicated. The difficulties are increased by the presence of organisms which are responsible for the formation of humus, a product of extreme importance in the soil but of which little is known. The most important elements of the soil are O, Si, Al, and Fe; accordingly, if we know the fate of these elements, we must necessarily have an idea of the weathering processes. Originally these elements exist chiefly as quartz and aluminium-iron-silicates. The weathering processes cause their solution or decomposition, usually in the form of colloids. When the basic concentration of the water reaches a definite value these gels are coagulated. Such colloidal precipitates containing large amounts of Si are known as "sayalites" in international nomenclature; those low in Si as "alites." The weathering processes may be divided into three classes: (1) The wet region where the water penetrates the ground, dissolving materials. As the water penetrates, a concentration is reached where precipitation takes place. Gradually these precipitated substances are carried to the ocean. (2) Arid regions where the water evaporates, precipitating the dissolved material at the surface. Here the dissolved material remains in the soil. (3) A transition region known as the savannas. Climate also is an important factor so that these regions may be subdivided thus: (1*a*) The cool, wet region, in which humus acids are an important constituent. These acids react with the primary minerals, dissolving aluminium silicates, while SiO_2 is left behind. Consequently there results an SiO_2-rich sand while Al and Fe are carried away. No new minerals are formed. (1*b*) The warm wet region in which the humus acids are readily decomposed or are weaker acids than those of 1*a*. Al and Fe are carried away while SiO_2 remains. Carbonates often exist in this region. Loam is also found here. Loam is not a decomposition product but a reaction product, a gel. It is a sayalite with some little primary mineral remaining. The aluminium-silicates are not dissolved as in 1*a*, but are decomposed. The bases and some silicic acid are removed while the sesquioxides remain in excess. Crystalline kaolin may exist. In other sections of this region decomposition may proceed further so that Al_2O_3 gel and hydrargillite are formed. (2*a*) In the dry region soluble salts are found. The reactions are alkaline. The high electrolytic concentration of the water causes rapid precipitation of the SiO_2, which then occurs as a contamination product and not as a residual product. It often contaminates the kaolin and carbonates which occur in such regions. (3*a*) In the savannas in temperate zones, alites are formed. In certain sections they are known as bauxites. Humus is not important here because it is quickly decomposed. (3*b*) In savannas where extremes of temperature prevail all bases are removed and Al_2O_3 and Fe_2O_3 become active. During dry periods they are carried to the surface and deposited as iron ores and trihydrallite. The action of the sun's rays is important insofar as it causes these gels to crystallize as magnetite and monoaluminium hydrate. L.T.B.

Difference in heat content of a crystal and of its melt in comparison to softening temperature of glass and of melt of the crystal. G. TAMMANN. *Z. anorg. allgem. Chem.*, **190** [1], 48–52 (1930).—At temperatures below the temperature (T_g) at which brittleness occurs in glasses, the heat content of a material in the crystalline and in the glassy state is almost the same; above T_g the heat content of the liquid increases more rapidly than that of the crystal. At the melting point the heat contents of the two differ by ΔW, which is not the heat of melting. T. then shows how to obtain this temperature, T_g, theoretically. At this temperature there is a break in the isobars of all physical properties; specific heats and volumes begin to increase more rapidly above

this temperature. The temperature, T_g, may be determined to ± 2 to 5° from brittleness experiments, and from heat expansion experiments to $\pm 5°$. L.T.B.

Equilibrium between iron, nickel, and their silicates in melt. H. ZUR STRASSEN. *Z. anorg. allgem. Chem.*, **191** [3], 209–45 (1930).—Equilibrium studies were made in the system Fe + $NiSiO_3 \rightleftharpoons$ Ni + $FeSiO_3$. The displacement of equilibrium by the addition of foreign materials such as $MgSiO_3$, SiO_2, Al_2O_3, CaO, and TiO_2 was also followed. There is included a discussion of the results as they may be applied to the problems of meteoric and geochemical equilibrium. L.T.B.

New method for determination of small changes in length and its application in measuring coefficient of expansion of glasses and ceramic materials. R. THILENIUS AND H. HOLZMANN. *Z. anorg. allgem. Chem.*, **189** [4], 367–87 (1930).—The determination of small changes in length were formerly made by use of a measuring arm with a scale, or optically with a mirror system. For precision measurements, the relative changes in length of a body were made by comparing them with two fixed lines. Then the temperature coefficient and elastic coefficient of the instrument had to be known; and slight bending on handling caused errors of considerable magnitude. These errors can be avoided if the reference lines are made independent of the microscope and put on a control rod. The difficulty arises as how to align the control rod and bar to be measured. They should be in one plane and so close that they may be measured in one field by an ocular micrometer. This also leads to mechanical difficulties. Only when these difficulties are removed are good results obtained. They may be avoided if, as reference lines, a virtual image of a measuring rod is taken, and by means of mirrors it is thrown into the plane of the microscopic enlargement of the bar to be measured. The apparatus is described. Temperature coefficients were then measured. Maximum error was 3 to 10%; results could be reproduced to 1%. Fischer and Supremax glass, Marquard mass, and MgO all showed a regular increase in coefficient of expansion as the temperature increased. Pythagoras mass showed a marked increase of coefficient of expansion between 700°C and 800°C, and above 800°, a decrease, which may be due to a chemical change in the material. Meissner porcelain showed a decrease between 600°C and 700°C, and a large increase between 700°C and 800°C. ZrO_2 showed a change in modification between 1044°C and 1099°C. It was possible to obtain the high-temperature modification if quenches were made of very thin pieces of ZrO_2 from 1300°C. The coefficient of expansion of this form is much greater than that of the low-temperature form. L.T.B.

Sulphite lye increases viscosity of slurry. KARL BIEHL. *Tonind.-Ztg.*, **54** [23], 396–97 (1930); *Rock Prod.*, **33** [15], 83 (1930); *Pit and Quarry*, **20** [10], 76 (1930); for abstract see *Ceram. Abs.*, **9** [7], 583 (1930). (Please note that a correction has been made for the page number of *Tonind.-Ztg.* in July). W.W.M.

Determination of iodides in presence of other halogens. S. W. GORBATSCHEFF AND I. A. KASSATKINA. *Z. anorg. allgem. Chem.*, **191** [1], 104–12 (1930).—A new method is described by which iodides are oxidized by means of $KMnO_4$ in an acid solution in the presence of excess chlorides. Chloroform is used as an indicator which is colored at first by the iodides and then decolorized at the end point of the titration. An electrometric method for the determination of iodides in the presence of bromides and chlorides is also described. These methods are more convenient and more reliable than the iodide determination by the nitroso method. L.T.B.

Structure of nepheline and analcime. E. SCHIEBOLD. *Naturwissenschaften*, **18** [31], 705–706 (1930).—Nepheline belongs to the space group C_6 with 8 molecules $NaAlSiO_4$ in the unit cell. It has a tridymite-like structure. Analcime apparently belongs to the tetragonal system with space grouping O_h^{10}. The most important conclusion drawn from these studies is that the constitution of the aluminium silicates is different from the Al_2O_3-free silicates. L.T.B.

Thermal revision. II. W. A. ROTH AND G. BECKER. *Z. physik. Chem.*, **145** [6], 461–69 (1929).—The heat of formation of ZrO_2 was determined in a bomb calorimeter. The new value of 264.0 ± 0.3 k.-cal. is higher than the former value of 177 k.-cal. The heat of formation of ZrC is 52.5 k.-cal. The heat of formation of Cr_2O_3 from chromium metal is 288.0 ± 1.0 k.-cal. In reducing $2CrO_3$ to Cr_2O_3, 6.1 ± 0.2 k.-cal. are absorbed. The heat of formation of CrO_3 is 147.1 ± 0.6 k.-cal. The following densities were newly determined at 21°C: ZrO_2 = 5.68 ± 0.02; Zr = 6.47; Cr_2O_3 = 5.20 to 5.21; CrO_3 = 2.80 ± 0.01. For Part I see *Ceram. Abs.*, **9** [4], 309 (1930). L.T.B.

Diffusion phenomena in some solid tungstates and molybdates. WILHELM JANDER. *Z. anorg. allgem. Chem.*, **191** [3], 171–80 (1930).—In reaction in the solid state, the rate of diffusion of materials is important. This rate was studied in various tungsten and molybdenum compounds by a determination of the element exchange in them. Cubes of the pure materials were made and dried. The surfaces were then flattened and one cube, *e.g.*, of $BaWO_4$, was placed on a cube of $SrWO_4$ and held at 800 to 1000°C for several days. At the end of that time they were broken apart, thin sections (0.01 to 0.02 cm.) sawed from them and the amount of exchange of Ba and Sr was determined in successive sections. After determining how far one compound had diffused into the other, the diffusion coefficient, D, was calculated from the relation

$$D = \frac{y^2}{2 \cdot c \cdot z}$$

when c remains constant, y = depth of diffusion, z = time in days, and c = concentration of diffusible material at surface of contact. Experiments showed that the metal shows but little tendency to diffuse whereas the acid radical diffuses more readily. In heavy metal compounds, both the metal and the radical take part in the diffusion.

L.T.B.

System CaO–H_2O. GUSTAV HÜTTIG AND ANTON ARBES. *Z. anorg. allgem. Chem.*, **191** [3], 161–70 (1930).—Hydration and dehydration studies were made in this system at a water vapor pressure of 10 mm. The compound $CaO \cdot H_2O$ decomposes at 390°C.

L.T.B.

Equilibrium studies in the system Al_2O_3-Na_2O–H_2O and Al_2O_3–K_2O–H_2O. R. FRICKE AND P. JUCIATIS. *Z. anorg. allgem. Chem.*, **191** [3], 129–49 (1930).—In the presence of water Al_2O_3 forms $Al(OH)_3$. The change oxide ⟶ hydroxide is slow so that $Al(OH)_3$ was used in these studies. The solubility of $Al(OH)_3$ in alkalis was determined at 30°C and 60°C. As the concentration of Na_2O increased in the solution, the amount of Al_2O_3 dissolved increased to a maximum at about 20% Na_2O. In higher concentrations of Na_2O there was a decrease in the solubility of the alumina. In K_2O solutions the solubility curves were similar but the maximum solubility of Al_2O_3 occurred in a 30% K_2O solution. The Al_2O_3 residue, when the concentration of the Na_2O and K_2O was less than the maximum, consisted of $Al_2O_3 \cdot 3H_2O$. Beyond the maxima, the residue was a water-soluble crystalline material. In K_2O solutions this material was $K_2O \cdot Al_2O_3$ with 3.3 to 5.8 H_2O; in Na_2O solutions it consisted of $Na_2O \cdot Al_2O_3$, which occurred as birefracting quadratic plates or prisms. When the concentration of Na_2O reached 38%, another type of crystal appeared. It consisted of long birefracting prisms, apparently $3Na_2O \cdot Al_2O_3$, with approximately 9 molecules of water. The monoaluminate compound had a composition: $2Na_2O \cdot 2Al_2O_3 \cdot 5H_2O$. The method of preparation of both of these compounds are given. Microphotographs of both are included. A comparison with the work of Goudriaan is included. The solubility of his $Al(OH)_3$ preparations was far less than that reported in this paper. L.T.B.

Method for measuring forces which occur during coagulation. A. V. BUZAGH. *Naturwissenschaften*, **18** [20], 444–47 (1930).—It is known that there are many forces between the particles of disperse systems. In order to know more about the attractive

forces between these particles, B. used a direct method to determine them. The principle of the method depends on the adherence of the particles of a suspension, *e.g.*, a quartz suspension, to a plate of the same material. Experimentally, the measurement of the force may be done in two ways. (1) Determination of the "adherence number," *i.e.*, the number of microscopic particles of a quartz suspension which, under the same conditions, adhere to a plate of the same material (quartz). The particles are allowed to settle on the plate which is then turned over and the number which adhered is counted. The "adherence number" is the percentage of adhering particles. (2) Determination of the "detachment number." This is measured by turning the quartz plate on its horizontal axis and determining the angle at which the settled particles just move. A theoretical discussion follows. L.T.B.

Studies on the system Na_2O-SiO_2-ZrO_2. J. D'ANS AND J. LOFFLER. *Z. anorg. allgem. Chem.*, **191** [1], 1–35 (1930).—*The binary system ZrO_2–SiO_2.* One compound, $ZrSiO_4$, is reported but no new work was done in this system. *The binary system Na_2O–ZrO_2.* One compound, Na_2ZrO_3, was found; it dissociates at 1500°C; it is biaxial negative with indices $\alpha = 1.720$, γ above 1.80; density = 4.0; it crystallizes as plates. *The binary system Na_2O–SiO_2.* The data given for the portion of this system lying between Na_2SiO_3–SiO_2 agrees with that given by Morey and Bowen, *i.e.*, the 2 compounds, $Na_2Si_2O_5$ and Na_2SiO_3, were found in that portion of the diagram. The authors also report a compound, $Na_6Si_2O_7$, a pyrosilicate. It crystallizes as small plates which are biaxial positive (?). The indices of refraction are $\alpha = 1.524$, $\gamma = 1.529$; density = 2.96; it melts congruently at 1122°C. Another compound, Na_4SiO_4, crystallizes in the system as plates which are biaxial negative; it is only weakly birefracting with a mean refractive index = 1.536; at 960°C, this form changes to β-Na_4SiO_4; the compound melts at 1083°C. Three ternary compounds were found in the system: (1) Na_2ZrSiO_5 crystallizes as pseudo-hexagonal prisms; it is biaxial negative; indices of refraction: $\alpha = 1.741$, γ just below 1.790; density = 3.605; it dissociates at 1477°C. (2) $Na_4Zr_3Si_3O_{12}$ crystallizes as rhombohedrons; it is uniaxial negative; indices of refraction: $\epsilon = 1.692$, $\omega = 1.715$; density = 2.88; the compound melts congruently at 1540°C. (3) $Na_2ZrSi_3O_7$ crystallizes as long needles with inclined extinction; indices of refraction: $\alpha = 1.688$, $\gamma = 1.710$; it is biaxial; the solubility of the zirconium compounds in the sodium silicate melts is very slight. The melting point lowerings by such solution is only 20° at a maximum. The work is confined to the fields relatively low in zirconium. Isotherms, eutectics, and boundary curves in that portion of the field are given. L.T.B.

Separation of solids from liquids. ANON. *Rock Prod.*, **33** [18], 52 (1930); for abstract see *Ceram. Abs.*, **8** [3], 209 (1930). W.W.M.

Confirmatory tests for zinc. J. ST. PIERCE AND E. D. NAVE. *Ind. Eng. Chem., Anal. Ed.*, **2**, 190 (1930); *Sprechsaal*, **63** [30], 565 (1930).—The titration of zinc with potassium ferrocyanide and uranyl acetate as indicator can be used as confirmatory test when the disturbing ions are previously removed. This method has the added advantage that the zinc content can be exactly determined in per cents. Zinc is separated from the members of the third group, with the exception of iron, by precipitation with hydrogen sulphide in 1 *N* acetic acid in the presence of sodium acetate and dissolved in 1 *N* hydrochloric acid. The remaining traces of iron which are especially injurious in their 3-valenced state, and manganese, which can be only incompletely separated from zinc by this method, especially at higher concentrations, are separated by precipitation with sodium hydroxide and sodium peroxide. Traces of aluminum are not injurious, and chromium in the 3-valenced state only so when it colors the solution in higher concentrations. Injurious reducing and oxidizing agents are already destroyed by precipitation with hydrogen sulphide. The latter is removed by evaporating to dryness and

dissolving the residue in a small quantity of 1 *N* acetic acid. An equal volume of 0.01 *N* uranyl acetate is added to this solution combined with acetic acid and the required number of drops (15 to 17 drops correspond to 1 cc.) of 0.5 *N* ferrocyanide solution measured out by a drop flask is added until the appearance of a clear blue color. In case more than 15 drops are needed or the solution seems to be colored by impurities, a corresponding addition of uranyl acetate must be added. The number of drops of ferrocyanide required gives the approximate mg. of the zinc in the solution. M.V.K.

Fine ceramic masses. ANON. *Ind. dei Silicati; Corriere ceram.*, **11** [7], 289–93 (1930).—All the ceramic masses used in industry which give good products when fired were grouped on the basis of definite characteristics of their chemical composition by Pukall (*Sprechsaal*, Nos. 13 to 20, 1915). In practically all masses the proportion between the acid and basic components varied between 1:1 and 1:2. Silicic acid as the acid and alumina as the base with CaO and K_2O (or FeO) vary between 0.3 and 0.7 in the radical RO of the Seger formula. Choosing the following radicals,

$$RO = \begin{cases} 0.3K_2O \\ 0.7CaO \end{cases} \quad \text{and} \quad RO = \begin{cases} 0.7K_2O \\ 0.3CaO \end{cases}$$

maintaining the above-mentioned proportion between the acid and bases, and fixing appropriate proportions between the Al and SiO_2, a group is established which includes all ceramic masses, not only those actually in use, but also all further possibilities which can be worked out. Among the two series of masses which begin with the formula $RO{\cdot}0.33Al_2O_3{\cdot}2SiO_2$, P. chose the initial value $0.33Al_2O_3$ with the quantity of silica necessary to have the proportion between acids and bases of 1:1.2, 1.4, 1.6, 1.8, and 2:1, and established 6 series of masses by increasing the Al_2O_3 content and diminishing the SiO_2 until a maximum content of $0.7Al_2O_3$. As raw material for the preparation of the masses, P. used Zettlitz kaolin, quartz ground and sifted through a sieve of 9200-mesh per sq. cm., feldspar, and marble. The test cones made from this mass were fired to Seger cones 7, 9, 12, 14, and 16. The results provide instructive material for the study of the behavior of masses on firing and in relation to the quantity of CaO and K_2O in the radical RO of the Seger formula. From the behavior of these test masses, regulations are easily established for the composition and structure of masses not only on the basis of the chemical analysis of the raw materials used and on the proportion between the acids and bases, but also by fixing the firing temperature in order to have the desired ceramic products. It is also relatively easy to determine the admixtures for definite raw materials in order to obtain the desired or required characteristic. Dorfner (*Sprechsaal*, Nos. 24–50, 1915) demonstrates that the rational analysis for the study of fine ceramic masses is not sufficient and that calculations of the masses on the basis of the Seger formula alone give only (*a*) the exact proportion of the CaO and K_2O constituents in the RO radical, (*b*) the exact proportion between the bases and acids, (*c*) probable behavior on firing, and (*d*) the proportion between the difficultly fusible and easily fusible components, providing they are finely divided and perfectly homogeneous. The compositions of fine ceramic masses, according to D_{4}, usually vary between the limits of 2.5—:3.5 SiO_2, 0.5—:0.8Al_2O_3, RO. A table of typical ceramic masses is given. D. proves that (1) no type of porcelain exists in which the radical RO of the Seger formula contains only K_2O; and no calcium earthenware exists in which the RO of the Seger formula is made up only of CaO. (2) The degree of acidity of all fine ceramic masses should vary between normal limits and ought to be bases : acids = 1 :(1–2) and it happens that (*a*) the more the degree of acidity approaches the lower limits, the better will the masses react to firing; (*b*) the higher the degree of acidity above the upper limits, the less resistance to firing will the masses have, especially as porcelain and earthenware masses tend to become brittle, and thick earthenware does not retain the glaze. (3) The

composition of the RO radical in the Seger formula has a great influence on all fine ceramic masses, since only for an absolutely constant molecular composition and then only with equal acid content and the use of equal raw materials, do the following concepts hold good: (*A*) For glazed ware (porcelain, glazed, and thick earthenware) (*a*) the more K_2O in the RO radical of the Seger formula, the lower the firing temperatures; and the greater the CaO in the RO radical, the higher the firing temperature; (*b*) the less K_2O in the RO radical, the more plastic is the mass with the same raw materials, and vice versa; (*c*) the less K_2O in the RO radical of a porcelain mass, the greater the resistance to firing. (*B*) For unglazed masses (*a*) the more CaO in the RO radical, the more delicate the ceramic product; the more K_2O, the harder the ware for equal molecular structures and equal firing temperatures; (*b*) the more CaO in the RO radical the less the glaze tends to crack, especially in earthenware. (4) The following considerations hold good for a porcelain mass with an equal quantity of fired white clay: the less plastic the clay, the whiter the color and the greater the transparency of the fired product. M.V.K.

Microscopical examination of coal. J. LOMAX. *Gas Jour.*, **191** [3505], 205–206 (1930).—Microscopic examination with chemical analysis yields information of great use in the selection of coals for particular purposes. Quality is determined by the presence in varying amounts of four ingredients, clarain, durain, vitrain, and fusain, which research has shown constitute coal. Clarain has a bright-banded finely laminated appearance in the block. It is composed of leaf tissue, cuticle, and fragments of stems and twigs. Durain owes its name to its toughness and durability. Vitrain has a glassy vitreous appearance. Fusain, formerly known as "mother of coal," "soot," and "smudge," is soft, rarely solid, and easily soils the fingers. Clarain and vitrain cause swelling of the coal to 3 or 4 times its original volume when heated, and give off large quantities of gas. G.R.S.

Optical rotary power of quartz. T. M. LOWRY AND C. P. SNOW. *Proc. Roy. Soc.* [London], **A127**, 271 (1930); *Sprechsaal*, **63** [35], 664 (1930).—In a previous work, Lowry and Coode-Adams (*Phil. Trans.*, **A226**, 271 (1927)) demonstrated that the rotary dispersion of quartz over a large range of waves can be expressed by two magnitudes of the ultra-violet field and a small constant value. The validity of this equation can be proved also for the long wave-lengths by measuring the rotary power of the wave-lengths from 18,000 to 28,000 Å. At 28,000 Å an absorption band appears which makes further measurement impossible. The second field of investigation lay between 31,800 Å and 32,100 Å and joined onto the absorption band just mentioned. This stretch makes a little "window" of 300 Å in which further measurements are possible. Beyond these wave-lengths no measurements are possible as the permeability of quartz is extremely small here and the rotary power sinks 0.5° to the mm. The equation reads:

$$\alpha = \frac{9.5639}{\lambda^2 - 0.0127493} - \frac{2.3113}{\lambda^2 - 0.000974} - 0.1905.$$

The average deviations between the observed and calculated values are:

Å	°/mm.	Å	°/mm.
0.67	−0.0008	2.3 — 2.39	+0.0030
1.8 — 1.89	+0.0027	2.4 — 2.49	+0.0050
1.9 — 1.99	+0.0021	2.5 — 2.59	+0.0029
2.0 — 2.09	+0.0028	2.6 — 2.69	+0.0048
2.1 + 2.19	+0.0031	2.7 — 2.79	+0.0050
2.2 — 2.29	+0.0033	3.18 — 3.21	+0.0090

Indications of a cotton effect in the vicinity of the absorption band mentioned above were not observed. It is difficult to decide whether the rotary power of quartz between

28,000 and 1850 Å is influenced by the much more intensive absorption bands as 8.5, 9.0, and 20.7 μ. In contrast to the constant in the equation above, the constant in the equation for partial rotation varies as follows:

Å	Constant
6,707	—0.173
18,000	—0.179
27,000	—0.189
32,000	—0.197

The authors conclude that the equation for the rotary dispersion of quartz suffices for all wave-lengths hitherto examined and that the introduction of special constants for the ultra-red does not seem necessary. M.V.K.

Behavior of hydrogen chloride in different solvents. W. F. KENDRICK WYNNE-JONES. *Jour. Chem. Soc.*, pp. 1064–71 (May, 1930). E.C.C.

Determination of fluorine compounds. G. A. SHUEY. *Jour. Assn. Official Agric. Chemists*, **13**, 159–60 (1930).—Improvements in the volatilization method of determining F have been made, but it is recommended that the study of the method should be continued. H.H.S.

Determination of boron in soils. EDITORIAL. *Jour. Assn. Official Agric. Chemists*, **13**, 153–54 (1930).—Research is requested on a rapid method capable of determining B with precision to parts per million. Existing methods are reviewed, and it is said that Al, Fe, and Cr are interfering elements. H.H.S.

Determination of less common metals in soils. J. S. MCHARGUE. *Jour. Assn. Official Agric. Chemists*, **13**, 164–67 (1930).—Methods for determining Cu, Mn, and Zn are given. H.H.S.

Volumetric determination of phosphoric acid. W. H. ROSS. *Jour. Assn. Official Agric. Chemists*, **13**, 203–207 (1930).—R. discusses the influence of sulphates on the accuracy of the method. H.H.S.

BOOKS

Colloid Chemistry. Vol. I. JEROME ALEXANDER. D. Van Nostrand Co., New York, 1929, 3rd ed., 270 pp., $3.00. *Jour. Western Soc. Eng.*, **35** [3], 228 (1930).—This book is the result of an attempt to compress within a limited space the most important general properties of colloids and some of the practical applications of colloid chemistry. For Vol. II see *Ceram. Abs.*, **8** [4], 301 (1930). W.W.M.

X-Rays. B. L. WORSNOP. Methuen and Co., Ltd., London, 1930. *Mech. World*, **88** [2276], 158 (1930).—A chapter is devoted to the Bragg spectrometer, along with the related considerations of Moseley's experiments and the limitations of this method of crystal analysis. Chapter III deals with the scattering of these rays on the Thomson theory, and also the Compton theory of this phenomenon. Later chapters discuss emission, absorption, photo-electrons, ionization, reflection, refraction, and diffraction. E.P.R.

X-Ray Technology. H. M. TERRILL AND C. T. ULREY. D. Van Nostrand Co., New York, 1930, 256 pp. Illustrated. $4.50. Reviewed in *Mining and Met.*, **11** [285], 14 (1930).—This is a manual for the X-ray laboratory by two experienced physicists. The practical aspects of X-ray measurements, especially as applied to therapy and industry are emphasized. Much space is given to describing instruments and apparatus, and methods of using them. E.J.V.

Annual Tables of Constants and Numerical Data. (Tables Annuelles de Constantes et Données Numériques.) Vol. 7, Part 1. Compiled by COMITÉ INTERNATIONAL, 1930. 946 pp. $25.00 per set (2 volumes). Reviewed in *Mining and Met.*, **11** [285], 14 (1930).—This annual summary of chemical, physical, and engineering facts reviews

the new constants and numerical data that have appeared in the leading periodicals of the world. Because of its completeness and convenience, it is almost indispensable to research workers in every line. It forms, also, a supplement to the International Critical Tables (see *Ceram. Abs.*, **9** [7], 585 (1930)). The present volume covers the years 1925 to 1926. E.J.V.

Properties of Silica. ROBERT B. SOSMAN. The Chemical Catalog Co., New York. 856 pp. Reviewed in *Tonind.-Ztg.*, **54** [61], 1019 (1930). M.V.K.

Condensed Chemical Dictionary. ANON. Westman Publications, Ltd., Toronto. Reviewed in *Can. Chem. Met.*, **14** [8], 48 (1930); for abstract see *Ceram. Abs.*, **9** [10], 888 (1930). E.J.V.

X-Ray Investigations. (Röntgenographische Untersuchungen.) Supplement to *Mikrochemie*, **8**, 1930. 58 pp. Published by Verlag Haim, Vienna. 4 M. *Z. angew. Chem.*, **43** [29], 660 (1930).—The physical principles underlying the X-ray examination of materials is treated in the first part of this book by Regler. Neuberger gives the application of X-rays to chemistry while Jona outlines the construction of the X-ray apparatus for testing materials. See also *Ceram. Abs.*, **9** [7], 586 (1930). L.T.B.

Handbook of Mineral Chemistry. (Handbuch der Mineralchemie.) C. DOELTER AND H. LEITMEIER. Vol. 4. Price 8 M. *Z. physik. Chem.*, **148** [4], 319 (1930); for abstract see *Ceram. Abs.*, **9** [3], 234 (1930). L.T.B.

Notes on Hydrogen Ion Concentration. LEEDS AND NORTHRUP CO. Reviewed in *Mining and Met.*, **11** [285], 14 (1930); *Rock Prod.*, **33** [18], 52 (1930); for abstract see *Ceram. Abs.*, **9** [9], 791 (1930). E.J.V.

Flotation Reagents in the United States. T. H. MILLER AND R. L. KIDD. *Engineering*, **130** [3370], 219 (1930); for abstract see *Ceram. Abs.*, **9** [10], 188 (1930). A.A.

PATENTS

Precipitating titanium compounds. PEDER FARUP. U. S. 1,773,727, August 26, 1930. The process of precipitating titanium compounds by hydrolysis which comprises heating a titanium solution to cause precipitation of titanium compounds therein, and adding during the precipitation another titanium solution in amount sufficient to maintain a substantially constant composition and to make up for the titanium compounds so precipitated.

Preparation of magnesium bichromate. GEORG KRÄNZLEIN AND ARTHUR VOSS. U. S. 1,774,018, Aug. 26, 1930. A process of preparing magnesium bichromate which comprises reacting a bichromate of an alkali-forming metal with a magnesium salt of an acid which forms with an alkali-forming metal a salt which is less soluble in water than the magnesium bichromate.

Production of iron-oxide pigments. JULIUS LAUX. U. S. 1,774,930, Sept. 2, 1930. In the process of reducing an aromatic nitro compound involving the treatment of the nitro compound with iron and an agent which is hydrolyzable in water to produce hydrogen ions, to the production of the corresponding amine and an iron oxide sludge, the steps of improving the pigmenting properties of the iron-oxide sludge, which consist in using as the aforesaid agent a dilute aqueous solution of a salt containing aluminum as metallic base, and thereafter separating the sludge from the reaction mixture and purifying the separated sludge by levigating and washing out.

Production of iron-oxide pigments. JULIUS LAUX. U. S. 1,774,931, Sept. 2, 1930. In the process of reducing an aromatic nitro compound involving the treatment of the nitro compound with a reducing agent comprising iron and an agent which is hydrolyzable in water to produce hydrogen ions, to the production of the corresponding amine and an iron-oxide sludge, the steps which consist in using as the reducing agent a mixture of iron, aluminum metal, and hydrochloric acid in amount insufficient to dissolve the iron and reacting with the aluminum and other ingredients to improve the

pigmenting properties of the resulting iron-oxide sludge, separating the resulting sludge from the reaction mixture, purifying the former by levigation and washing out, drying, and calcining the resulting product.

Production of iron-oxide pigments. JULIUS LAUX. U. S. 1,774,932, Sept. 2, 1930. In the process of reducing an aromatic nitro compound involving the treatment of the nitro compound with a reducing agent comprising iron and an agent which is hydrolyzable in water to produce hydrogen ions, to the production of the corresponding amine and an iron oxide sludge, the steps for improving the pigmenting properties of the iron-oxide sludge which consist in using as the reducing agent a mixture of iron, a dilute aqueous solution of aluminium chloride, and hydrochloric acid in amount insufficient to dissolve the iron, separating the resulting iron-oxide sludge from the reaction mixture, purifying the former by levigation and washing out, drying, and calcining the resulting product.

Manganese dioxide. Y. KATO AND K. YAMAMOTO. Brit. 330,257, July 30, 1930. Manganese dioxide is produced by heating any natural or artificial lower oxide, or any compound of manganese converted into the lower oxide by heating, from 200 to 500°C in the presence of 3 to 5% alkali, *i.e.*, the oxide, hydroxide, or carbonate of an alkali or alkaline earth, while passing oxygen or a free oxygen-containing gas, such as air, over the mixture. The velocity of the reaction is accelerated by the addition of steam to the oxygen. When the oxidation is complete, the product is washed with water, or with dilute acid, when alkaline earths are employed. In a modification of the process, the alkali is first added to a portion of the lower oxide, and heated in the presence of oxygen to form the manganate. The remainder of the lower oxide is now added to obtain the dioxide. Reference has been directed by the Comptroller to Specifications 132,114 and 135,305.

Borax. AMERICAN POTASH & CHEMICAL CORP. Brit. 330,453, July 30, 1930. The calcined borax is crushed to break up the cellular structure, and to increase the apparent specific gravity to approximately 0.95. A double roll-type crusher is preferably employed, so that excessive pulverization does not occur, and the product contains very little dust.

Titanic acid. I. G. FARBENIND. A.-G. Fr. 35,377, May 25, 1928. Addition to 653,893. Easily soluble Ti compounds and very pure TiO_2 are prepared by rapidly heating with K_2SO_4 and water the product obtained by treatment of ilmenite with H_2SO_4, filtering this solution, and washing the residue with H_2SO_4. (*C.A.*)

Treating clays. WM. FELDENHEIMER. Fr. 679,363, Dec. 11, 1928. Clays are decolorized by suspending them in an alkaline deflocculating agent, *e.g.*, aqueous Na_2SiO_3, and treating the suspension with the product of reaction of SO_3 on a metal which reduces SO_2, such as Zn or Al. (*C.A.*)

General

Packing of particles. A. E. R. WESTMAN AND H. R. HUGILL. *Jour. Amer. Ceram. Soc.*, **13** [10], 767–79 (1930).—It is axiomatic that the mode of packing of very large volumes of particles of uniform shape and size is independent of the size of the particles, provided they are large enough for the effect of electrostatic forces, air films, etc., to be negligible. An apparatus is described in which equal true volumes of approximately spherical particles, ranging in diameter from 0.2 to 0.0035 in., pack practically to the same apparent volume. This apparatus was used in studying the packing of mixtures of two and three sizes of particles. By plotting the data so obtained in diagrams of a particularly convenient character, it is shown that the apparent volumes of mixtures containing unit real volume of solid fall between limiting values which can be calculated

from simple assumptions, and that their deviation from these limits depends in a definite manner upon the diameter ratios of the component particles. The conditions governing the application of the results of the study to ceramic technology are pointed out.

Consistency of pugged clay. STANLEY C. JONES. *Trans. Ceram. Soc.* [Eng.], **29** [3], 112–13 (1930).—Clay in its brief passage through the pug receives a treatment equivalent to "wedging," causing lack of uniformity in consistency. A slice 1 x 6 x 6 in. was cut from the clay as it emerged from the pug mill. This was cut into 36 one-inch cubes, which were all numbered so that they could be refitted into their proper positions. These were weighed and placed to dry in air for two days and in an oven at 110°C for three days. After cooling in a desiccator, they were reweighed. From the loss in weight, the percentage moisture was computed. Dryness was noted in several cubes. Conclusion to be drawn is that clay should be more uniform when introduced into the pug mill. R.F.S.

Brick market. ANON. *Brick Clay Rec.*, **77** [4], 204–205 (1930).—In what type of structure is there most opportunity to increase the use for brick? According to a survey made by the American Face Brick Assn. in 302 typical cities, and based on U. S. Dept. of Labor building statistics, the total wall surface built annually is divided as follows: single family residences, 41.5%; two family residences, 12.7%; apartments, 13.0%; garages (all kinds), 14.9%; factories, stores, and warehouses, 8.6%; office buildings and all others, 9.3%. Estimates of the total of wall surface show that 38.5% of the total built annually is of brick. Basing calculations on a 9-billion annual production there is a potential market for 23,385 million brick if there were 100% brick wall surface construction. An analysis of the data shows that the best market for brick lies in the home building field, which market has already been sold on the desirability of brick construction. The market must be convinced that brick homes are not excessively high in first cost. Illustrated. E.J.V.

Estimating brickwork. ANON. *Blast Fur. Steel Plant*, **18** [9], 1506 (1930); reprinted from *Modern Refractory Practice*.—Figures that can be used in estimating the number of refractory brick required for walls or in arches are given. In the construction of sprung arches, rise and thickness, skewbacks, effect of temperature, and thrust must be considered. E.J.V.

Brick panel display. ANON. *Brick Clay Rec.*, **77** [5], 278 (1930).—J. Sullivan of the Wisconsin Lime & Cement Co., Chicago, has an ingenious brick display room in which his brick panels are kept in drawers in a steel filing cabinet and are instantly available for display to prospective customers. This enables the storage of a great number of panels in a relatively small space. Illustrated. E.J.V.

Resurfacing roads a cheaper way. WM. H. MOSELEY. *Brick Clay Rec.*, **77** [6], 318–19 (1930).—A new method of resurfacing old concrete roads with brick which promises to be considerably cheaper in first cost than any method now being used is described. It consists of replacing the heavy, 1-ft. thick curb of concrete with a T-shaped iron band, the stem of the T resting on the surface of the road. Metal tie rods hold the metal curbs in place. Illustrated. E.J.V.

Management in foundry operation. ANON. *Iron Age*, **125** [22], 1605–1606 (1930).—Personnel direction, sales analysis and market research, and the advantages of order and neatness are described. E.C.C.

Large economies possible through use of waste heat. CHARLES W. E. E. CLARKE. *Iron Age*, **125** [23], 1681–84 (1930). E.C.C.

Automatic feed-water regulators. ANON. *Colliery Guardian*, **141** [3632], 482 (1930).—An important phase of boiler plants is feed-water regulation, thus bringing the plant into line with such methods as the use of exhaust steam, feed heaters, economizers, air heaters, and superheaters, now beginning to be regularly employed, while for water-

tube boilers automatic control of the feed is essential. The advantages of feed-water regulators include uniform steam pressure, more efficient running of economizers and superheaters, better operation because of a constant steam space of proper proportions in the boiler, and freedom for the attendants to concentrate upon the firing. The essential troubles with many types of feed-water regulators have been complexity, undue wear and tear and breakdown, and failure to keep the water level more or less constant under conditions of fluctuating steam demand. A British regulator, the Hopkinson "Duo," on the thermostatic expansion tube principle is described in detail. Illustrated.

E.J.V.

Comparison of different types of boiler furnaces for peak-load working. ANON. *Colliery Guardian*, **141** [3633], 578 (1930); abstracted from *Z. Ver. deut. Ing.*—Peak-load operation of boilers places a big strain both on boilers and furnaces, owing to the necessity of frequently stoking and damping the fires. The masonry in particular suffers severely. Taking average conditions and boilers, roughly 2000 to 2200 service hours are utilized for repairs and cleaning. A furnace for peak-load operation (1) must be low in first cost, (2) must be capable of quickly raising steam or damping down the boiler, (3) must be "flexible" in regard to furnace efficiency, (4) exhibit low cooling losses, and (5) wear well. Some comparative tests carried out at a large power station with three types of furnaces, traveling grate, sliding grate, and coal-dust fired, serving similar boilers of 214-lb. pressure and generating 25 tons of steam per hour are described.

E.J.V.

What the American Ceramic Society should be doing. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [9], 263–66 (1930).—The answer to the question "What would the AMERICAN CERAMIC SOCIETY do with the income from a million dollar endowment" is given as "promote the use of ceramic ware." The reasons for this answer are elaborated upon.

E.J.V.

Coöperation with the architect. ANON. *Brick Clay Rec.*, **77** [6], 313–17 (1930).—This article is written to record what some architects see in the crystal glass of the construction industry and what the clay products industry is doing to crystallize these dreams. Some of the current modern developments in new clay products which are helping to set a new style in architecture are covered. Illustrated. E.J.V.

Migration of industry. ANON. *Iron Age*, **124** [17], 1089–90 (1930).—It has been estimated that $^{9}/_{10}$ of all industries are improperly located due to unscientific methods of location. Mergers and consolidations are doing a great deal to focus attention on proper location so as to lower costs to the consumer. There are 4 distinct types of industrial development: (1) growth resulting from the acquisition by relocation; (2) establishment of branch plants; (3) organization of new local industries; and (4) growth by expansion (no data taken). Reports from 1934 industries in the U.S. and 150 in Canada covering 16,000 firms employing 600,000 workers gave the following data. Relocations accounted for 10% of the plants gained by different communities, new local industries 80%, branch plants 9%. In the 2-year period covered by this survey, the various communities lost 58% as many as were gained. Of the losses, 82% went out of business while the remaining 18% moved away. The average size of the plant loss was 35 employees. Cities under 10,000 received more than $^{1}/_{4}$ of all the branches reported, more than $^{1}/_{6}$ of all relocations, and $^{1}/_{10}$ of the new local industries. Most frequently mentioned reasons for this movement in the order of frequency are markets, labor, transportation, materials, and available buildings. Practically 86% of the movement into New England was from the Middle Atlantic states. Conversely, most of the plants moving out of New England went to the Middle Atlantic states. As a whole, the middle Atlantic states showed the greatest gains due to relocation, with New England second. The Middle Atlantic states led in new branch factories with the East North Central

territory, second. The middle Atlantic states are substantially ahead in establishments of new local plants, New England, second. E.C.C.

An artist tours a glassworks. ANON. *Pottery Gas.*, **55** [639], 1449 (1930).—The artist describes and illustrates the old chimney type glasshouses and the manufacture of glass pots by the glassworks pot maker. E.J.V.

Cleaning belts with steam. A. F. SCHAPHORST. *Brick Clay Rec.*, **77** [6], 330 (1930).—The utmost caution must always be exercised in the use of steam for cleaning belting, since many kinds of belting cannot withstand the high temperatures that go with steam. Some of the various kinds of belting are discussed from this angle. See also *Ceram. Abs.*, **9** [4], 295 (1930). E.J.V.

Portable screen. DEISTER CONCENTRATOR CO. *Brick Clay Rec.*, **77** [6], 333 (1930).—The Concenco Type M Mobile Screen employs the same principles of vibration as are used in the Leahy NO-Blind Vibrating Screen, and due to its portability it is suited for a variety of uses about clay products plants, *e.g.*, screening and reclaiming setting sand that is shoveled up from the floor of the kiln floor flues. Illustrated. E.J.V.

Produce acid-resistant alloys. ANON. *Pit and Quarry*, **20** [11], 31 (1930).—Haynes Stellite Co., Kokomo, Ind., a unit of Union Carbide and Carbon Corp., has announced the completion of a new foundry at the Kokomo works, built expressly for the manufacture of the Hastelloys, a new group of acid-resistant alloys. The Hastelloys form a group of alloys with unique properties. Hastelloy A is the only alloy, available commercially, which resists the action of both hot and cold HCl, while Hastelloy C resists the action of wet chlorine. E.P.R.

Wind pressure on buildings. O. FLACHSBART. *Naturwissenschaften*, **18** [20], 475–79 (1930).—In buildings, the wind pressure plays an important rôle in calculating stresses and strains. The engineer distinguishes two types of problems which he must take into consideration when constructions are made: (1) aerological problems relating to the speed of the wind and its maxima in the various sections of the world; (2) aerodynamical problems or the pressure of the wind on a structure when it has a certain velocity. F. discusses the theoretical principles underlying these aerodynamical problems giving some of the data which are known about them. He also stresses how the wind-pressure problem deviates from ordinary hydrodynamic resistance problems. L.T.B.

Facing brick, road-paving brick, and roof tile, as manufactured in Ohio. G. A. HODSON. *Trans. Ceram. Soc.* [Eng.], **29** [4], 138–41 (1930); for abstract see *Ceram. Abs.*, **9** [1], 37 (1930). R.F.S.

Accident prevention and safety work. J. W. HIXSON. *Brick Clay Rec.*, **77** [6], 326–30 (1930).—H. discusses plant first aid, the safety organization, inspection service, the safety inspector, the safety committee and accident cases, educational service, and the bulletin board, and offers valuable suggestions in connection with each. E.J.V.

Rebuild commercial engines. ANON. *Abrasive Ind.*, **11** [9], 23–26 (1930).—Large operators of trucks and other automotive equipment find economy through use of modern abrasive tools. E.P.R.

Money spent for international exhibit of glass. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [9], 266 (1930).—Comments on the questions raised by visitors at the AMERICAN CERAMIC SOCIETY office are presented. The fact is brought out that our museums and stores feature foreign-made ware, and traveling exhibits are constantly being shown by museums in the large cities. E.J.V.

Sales clinic. E. ST. ELMO LEWIS. *Keramic Tile Jour.*, **2** [6], 14–27 (1930).—An address relating to sales, merchandising, advertising, and marketing problems delivered at the New Orleans convention is presented. W.C.O.W.

Building age. JAMES A. TRAHYAM. *Keramic Tile Jour.*, **2** [7], 22–25 (1930).—A sales talk emphasizes the use of tile in the kitchen as well as in the bathroom. Illustrated. W.C.O.W.

Technical classes for pottery and glass. ANON. *Pottery Gaz.*, **55** [639], 1448 (1930).—Particulars of classes to be held in various parts of England in connection with the manufacture of pottery or glass are given. E.J.V.

Some observations on American methods of manufacture. J. BURTON. *Trans. Ceram. Soc.* [Eng.], **29** [4], 115–20 (1930).—B. noted especially the following points: (1) high tariffs which protect the American market; (2) use of mechanical transportation; (3) number of technically trained men in charge of various departments; (4) standardization in methods used; (5) dependence of manufacturers on opinions of technical experts; (6) speeding-up methods; and (7) mass production. See also *Ceram. Abs.*, **9** [4], 292 (1930). R.F.S.

Increasing the radius of a market. ANON. *Brick Clay Rec.*, **77** [5], 280 (1930).—The American Truck & Body Co. has brought out the triple-load trailer with which it is possible to haul 3 loads of brick with no more handling than is required of one load. Illustrated. E.J.V.

West side Y.M.C.A., New York. DWIGHT JAMES BAUM. *Arch. Forum*, **53** [2] (Part 1), 147–50 (1930).—The style of architecture for this building is that of the 15th Century as found in the Italian provinces of Lombardy and Tuscany. A brick of pastel shades having a texture different from anything hitherto used in N. Y. was secured in S. Carolina. This was combined with polychrome terra cotta characteristic of that period. E.P.R.

Mosaics in Metropolitan Life Insurance Building, Ottawa. BARRY FAULKNER. *Arch. Forum*, **53** [2] (Part 1), 143–46 (1930).—The use of mosaic decoration on the ceiling of the lobby of the Metropolitan Life Insurance Bldg. gives in effect a large picture book. The processes for constructing these mosaics is described. E.P.R.

Coated abrasive makers to combine. ANON. *Abrasive Ind.*, **11** [9], 46 (1930).—A consolidation of Baeder Adamson Co., Philadelphia, with the Minnesota Mining & Mfg. Co., St. Paul, has been proposed under which the sandpaper and fiber interests of Baeder Adamson will be affiliated with the Minnesota Co. E.P.R.

Carborundum expands abrasive field. ANON. *Abrasive Ind.*, **11** [9], 26 (1930).—In taking over the two sandpaper and abrasive plants of the American Glue Co., the Carborundum Co. will add materially to its volume of business in these fields. E.P.R.

Chilean nitrate centenary. ANON. *Chilean Rev.*, **9** [33], 58–63 (1930).—The world export of nitrate from Chile in 1830 was 813 T.; now it is over 3,000,000 T. annually. A centenary commemoration was held in Paris, March, 1930. H.H.S.

Friedrich Rehrberg. CHARLOTTE STEINBRUCKER. *Sprechsaal*, **63** [32], 601–603 (1930).—The life and works of Rehrberg (1758–1835) famous painter of the State Porcelain Manufacture in Berlin are described. Illustrated. M.V.K.

Review and criticism of groups made from 1919 to 1928 by Meisner State Manufacture in Berlin. OTTO PELKA. *Sprechsaal*, **63** [34], 637–41 (1930). M.V.K.

Third Annual Conference of the Nat. Assn. of Clayworks Managers. ANON. *Refrac. Jour.*, **5** [59], 412–15 (1930).—The Third Annual Conference of the N.A.C.M., was held in Buxton, England, June, 1930. E.P.R.

Tile and Mantel Contractors' Association of America. ANON. *Keramic Tile Jour.*, **2** [8], 47–53 (1930).—A directory. W.C.O.W.

Lime museum in Rüdersdorf. ANON. *Tonind.-Ztg.*, **54** [39], 1663 (1930); *Rock Prod.*, **33** [14], 89 (1930).—A lime museum will be opened in October in Rüdersdorf near Berlin. The large deposits of lime in Rüdersdorf and its importance in German industry are outlined. These deposits were first used by monks in 1252. M.V.K.

World trade in ceramics at the end of 1929. KURT LUDWIG. *Keram. Rund.*, **38**, 7–11 (1930).—A detailed analysis of imports and exports of important producing and consuming countries is given. H.I.

World Power Conference. ANON. *Engineering*, **130** [3370], 213–16; [3371], 248–50 (1930); see also *Ceram. Abs.*, **9** [10], 892 (1930). A.A.

From the rock to the road. ANON. *Refrac. Jour.*, **5** [59], 408 (1930).—The Fourth Exhibition of Plant and Machinery in connection with the quarrying industry was held at Scarborough, England, July, 1930. The exhibition was organized by the Quarry Managers' Journal, Ltd. Here were exhibited the latest things in plant and materials for quarries and roadmaking. E.P.R.

Second British Glass Convention. ANON. *Pottery Gaz.*, **55** [639], 1432–33 (1930); *Nat. Glass Budget*, **46** [16], 14 (1930); for abstract see *Ceram. Abs.*, **9** [10], 891 (1930). E.J.V.

The Ceramic Society. ANON. *Pottery Gaz.*, **55** [639], 1430–32 (1930).—Other questions discussed at length by members of the Ceramic Society were: "What is the cause and remedy of pinholey backs in the making of plates?" and "Why should pinholes show after a second glost fire?" The answers to these questions are given. See also *Ceram. Abs.*, **9** [10], 891 (1930). E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **55** [639], 1456–58 (1930); for abstract see *Ceram. Abs.*, **9** [9], 799 (1930). E.J.V.

University of Sheffield. ANON. *Refrac. Jour.*, **5** [59], 391–98 (1930).—The University of Sheffield opened for inspection, July, 1930, new laboratories for the department of refractory materials. The new laboratories adjoin the Applied Science Dept., where the old laboratories are roomed which were erected for the Glass Technology Dept. The refactories department of the university was founded in 1917 to carry out investigations on refractory materials. Lecture courses were later established. The speeches given at the opening of the laboratories are included in the article. E.P.R.

Bulgarian ceramic industry. L. TONTSCHEFF. *Sprechsaal*, **63** [30], 559–61 (1930).—A description of the Bulgarian ceramic industry is given. Excavations showed that the industry already existed in the 9th Century, but under the domination of Turks it ceased almost completely to exist; activities were resumed about 80 years ago. The methods of working are out of date and the ware is of poor quality. Plastic, red-firing clays containing iron are used as raw materials. The composition of these clays is given. There is only one modern plant, the "Isida" plant which makes brick, clinker, stoneware pipes electric porcelain, and other objects. M.V.K.

Activities of the Kaiser Wilhelm Association for scientific studies. General report from April, 1929, to March, 1930. V. HARNACK AND V. CRANACH. *Naturwissenschaften*, **18** [20], 482–512 (1930). L.T.B.

BOOKS, BOOKLETS, ETC.

American Society for Testing Materials. Proceedings of 32nd Annual Meeting. Vol. 29, Part I. Committee Reports. New and Revised Standards. Price $6.00 Part II. Technical Papers. Headquarters of the Society, 1315 Spruce Street, Philadelphia (Price $6.00). Reviewed in *Engineering*, **130** [3371], 224 (1930). A.A.

Metal-Ceramics. Preparation of Metallic Bodies out of Metallic Powders. (Metallkeramik. Die Herstellung von Metallkörpern aus Metallpulvern.) FRANZ SKAUPY. Edit. Chemie, G.m.b.H., Berlin, 1930. 18 illustrations. 6 Rm. Reviewed in *Sprechsaal*, **63** [32], 615 (1930).—This book discusses the treatment of metallic powders by means of processes and methods used in ceramics, mainly the preparation of metallic bodies from metallic powders by sintering or fritting. The preparation and properties of the metallic powders are given; then the production of metallic ceramic bodies without and with setting agents and the properties of the latter. A special part is devoted to

the ceramics of tungsten, molybdenum, tantalum, and other metals. Other fields for metal-ceramics (catalyzers, coals, graphite bodies, etc.) are treated. S. describes the development of metal-ceramics, which in spite of the progress made, is only at its beginning, but promises to grow rapidly. This book is of interest for the silicate chemist because of new tests on metals with different raw materials given. M.V.K.

Ingenious Mechanisms for Designers and Inventors. Edited by FRANKLIN D. JONES. 536 pp. Published by Industrial Press, New York. *Abrasive Ind.*, **11** [9], 26–27 (1930).—This book is built on an earlier one entitled "Mechanisms and Mechanical Movements" and represents contributions of 110 experienced designers to the columns of machinery over a period of many years. The best material of the earlier book has been retained, but the scope of the work has been broadened generally. E.P.R.

Technical Arts and Sciences of the Ancients. ALFRED NEUBERGER. Translated by H. L. Brose. Macmillan Co., N. Y., 1930. 518 pp., illustrated. $10.00. Reviewed in *Mining and Met.*, **11** [285], 14 (1930).—This is an excellent book for the general reader, well printed, illustrated, covering a wide range of subjects: mining, metallurgy, metal-working, wood-working, leather, glass, ceramics, painting, brewing, agriculture, town-planning, fortifications, buildings and building materials, water-supply, drains and sewers, roads and bridges, ships and navigation, and early machines in general. E.J.V.

Corporate Earning Power. WILLIAM L. CRUM. Published by Stanford Univ. Press. 342 pp. *Abrasive Ind.*, **11** [9], 26 (1930).—The basis of this book is the finding of an analytical examination into the corporation statistics regularly published by the U. S. treasury in its annual compilation. It ranks as one of the most authoritative and revealing studies of corporation incomes in the U.S. E.P.R.

Man and His Universe. JOHN LANGDON-DAVIES. Harper & Bros., N. Y., 1930. 341 pp., illustrated. $5.00. Reviewed in *Mining and Met.*, **11** [285], 12 (1930). E.J.V.

Electricity for Beginners. EDWARD H. THOMAS. 170 pp. Published by the Norman W. Henley Publishing Co., N. Y. Price $1.50. Reviewed in *Brick Clay Rec.*, **77** [2], 116 (1930); *Abrasive Ind.*, **11** [8], 22 (1930).—The treatise, prepared by an experienced instructor, is written in language and terms that can be understood by those beginning their study of electricity. E.P.R.

New Ceramic Products Cyclopedia. ANON. *Ceram. Ind.*, **15** [2], 185–94 (1930); for abstract see *Ceram. Abs.*, **9** [9], 803 (1930). W.W.M.

Study of quarry costs. J. R. THOENEN. Bur. Mines, *Information Circ.*, No. 6291, 24 pp. (1930).—The present report summarizes the final tabulations of producing costs of (1) trap rock, (2) sandstone, and (3) granite quarries. R.A.H.

Engineering Materials. Vol. I. Ferrons. ARTHUR W. JUDGE. Sir Isaac Pitman and Sons, Ltd., London. Price 30s. Reviewed in *Engineering*, **130** [3369], 163 (1930). A.A.

Federation of British Industries. ANON. *Refrac. Jour.*, **5** [59], 402 (1930).—The *Fuel Economy Review* was first started in 1921 and is an attempt on the part of the F.B.I. to secure improved fuel practice by the dissemination of up-to-date information on fuel preparation and utilization. It concerns itself with gas, electricity, and oil, in addition to coal, and also with developments in fuel practice. The 1930 issue of the *Review* was published in June. It contains information on (1) rationalization of fuel purchase, (2) industrial tariffs for electricity, (3) boiler-house record sheets, and (4) smoke abatement; and 116 pages of matter other than the section devoted to advertisements. E.P.R.

Publications from the Kaiser-Wilhelm Institute for Silicate Investigation. (Veroffentlichungen aus dem Kaiser-Wilhelm-Institut für Silikatforschung.) WILHELM

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EDITORIAL

VALUE OF SYSTEMATIC STUDYING

The youths who disdain going to school cite the successful self-made man as evidence that class room training is not essential. They are partly right; formal class room training is not necessary; but a scheduled schooling is absolutely essential. The fact lost sight of by these disdainful youths is that an education obtained by scheduled studying is absolutely essential to success in any human endeavor and especially so in business and in manufacturing.

It is regrettable that in biographies more stress is not put on the fact that the "self-made" man who has attained eminence without having had much formal class room training actually spent many hours of systematic hard "grinding" on books and industriously made trial applications of the things he learned.

The laggard, the loafer, and the time waster do not have a chance in competition with the fact-applying student irrespective of the comparative amount of formal class room training each may have had. The college graduate who attempts to coast along without further studying will not succeed as well as will the "self-made" student who is continually studying. It is not the start; it is the continuing that makes for success; but the better the start, the speedier and further one can go, provided he continues.

A young man 27 years old asked admission to college to take special work. He had completed the fifth grade grammar school work and since then until he went to college he had been a machinist. He successfully completed quantitative chemistry, physics, advanced algebra, and several of the ceramic courses. He did not fail, nor did he have to drop any of the courses he undertook. Why? He had always been a student. He was better prepared for college than the average high school graduate. He knew how to accomplish. He exemplified what can be accomplished by practiced studying.

This same man also exemplifies what happens when one discontinues studying. After having successfully completed two years of university training he ceased systematic studying. He seemed to believe that what he knew was sufficient to carry him onto success. He did not progress simply because he ceased studying.

Benjamin Franklin was not as brilliant as were several of the brothers, but he was a student. He sought opportunities to read books and to learn from those who knew the things he wanted to know. He labored many hours daily in study not alone in youth but throughout his great and eventful life. He was a diligent searcher for information to the very end. He made a greater impress in history than have most of our presidents. His more brilliant brothers are not known other than as brothers of Benjamin Franklin.

Carnegie was a genius of a sort as is Edison, but the genius of both of these men was based on continued systematic studying.

Examples could be multiplied showing that success is to be gained only by continuous systematic studying. Discontinuance of studying, no matter how far one has progressed, will result in discontinuance of progress.

Furthermore mere studying and knowing things no matter how systematically the studying may have been or how well informed the person might be will not guarantee success. There must be an objective. Applications and correlations must be made. A bookkeeper who is intellectually alert and has an objective will make a better ceramist than will the best informed college graduate ceramist who discontinues his studying and is without definite objectives.

Success is more in the continuing than in the starting.

This AMERICAN CERAMIC SOCIETY is a means not primarily for making records, not primarily for publishing information, but as a coöperative aid in continued studying out the applications of observed facts to the economic production of high quality ceramic ware. Any person engaged in ceramic ware production who is not a working member of this AMERICAN CERAMIC SOCIETY is not availing himself of the most effective and inspiring means of making progress.

PAPERS AND DISCUSSIONS

INDUSTRIAL USES OF RUBBER[1]

By H. E. Fritz

ABSTRACT

A discussion of rubber-lined steel tanks for the purpose of storing and transporting muriatic acid and other corrosives is presented. Rubber-lined steel pipe, valves, and fittings for the transportation of corrosives, and the rubber cutless bearing are discussed.

Introduction

Rubber has many admirable properties, but its corrosion- and abrasion-resisting properties have the greatest interest for engineers. Utilization of these properties of rubber has always presented a difficult problem owing to limiting factors, such as lack of rigidity, lack of tensile strength, etc.

The discovery of the Vulcalock process, in which rubber is bonded to metal, has overcome some of the limiting factors, and has placed in our hands a new construction material, possessing a combination of properties which are very useful in solving baffling corrosion and abrasion problems.

Corrosion

Rubber has been found effective in meeting the needs of many corrosion-resisting applications. Rubber is now effectively resistant without contamination to all the acids except nitric and highly concentrated sulphuric. Rubber will successfully resist the corrosion of 50% sulphuric acid, 85% phosphoric acid, and the common corrosives such as hydrochloric acid and hydrofluoric acid; salt solutions present no problem at all when stored and transported in rubber-lined containers.

Abrasion

Special study has been given to the compounding of rubber for various kinds of abrasion-resisting service. For those who are not familiar with this quality of rubber, the example of the automobile tire and the skid chain is convincing; for all who have used skid chains on their motor cars know that the hard alloy steel links, when exposed to bare brick or concrete, will wear to a point of failure in a few hundred miles, while the tread of a good tire will travel thousands of miles, absorbing abusive impact and friction without showing any appreciable signs of wear.

Another striking example of the abrasion-resisting quality of rubber is evident in the protecting cover of conveyer belts, which carry millions

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division). Received June 21, 1930.

of tons of sharp abrasive ore and rock materials before the failure of a cover thickness often not exceeding $^1/_8$ inch.

The shell of a 5- by 22-ft. grinding mill in a cement plant charged with 45,000 lbs. of steel balls was lined with rubber 1 inch thick made in flat sheets. During the manufacturing process, a piece of gauze was placed between the rubber and the curing press, which left a permanent cloth imprint on the exposed surface of the rubber. After 90 days of continuous operation, inspection showed that the wear on the rubber had been so slight that this cloth imprint had not been removed. After 14 months of continuous service, the same lining was removed for inspection and the sheets were carefully calipered and at no place did the wear exceed $^1/_{64}$ inch from the original thickness.

A large manufacturer of abrasives required a machine to mix finely-divided abrasive material, and bronze arms were used in the mixer to eliminate a certain undesirable contamination, which would have occurred if iron or steel arms had been used. These bronze wearing parts gave a life of only six weeks, and were a source of trouble and expense. To test its effectiveness one of the arms was covered with one-eighth inch rubber. This thin coating has now been in service for 10 months, and is reported to be in excellent condition.

The operators of a sand dredge in the Ohio River placed a sheet of rubber at the discharge of a 36-inch conveyer, and there was concentrated over a very small area in a period of seven months the impact and scouring action of 250,000 cubic yards of sand and gravel. It was observed that the rubber outlasted ten steel plates of the same thickness and in the same service, with a substantial saving in cost over a steel lining and an incidental saving of time and labor. It was remarked that had this piece of rubber been shifted and favored, so that the wear would have been more evenly distributed over the entire surface, it could have been made to deliver 40 times the service of the same thickness of steel.

A number of other similar instances could be cited where rubber, when properly applied, is meeting the need as an effective covering in places where abrasion is present to a destructive degree. Those cited here are sufficient, however, to indicate that the field of useful applications will have a wide range.

The Vulcalock Process

This a process for attaching soft rubber to metal more securely than is possible through the adhesion afforded by cement or glue. Adhesion between the two materials is so complete that they appear to be integral, and the bond approaches the tensile strength of the rubber itself. Adhesion tests have shown a tensile strength in excess of 700 pounds to the square inch. The end of a steel bar with a 1-inch cross-section area was

attached by the Vulcalock process to another piece of steel, and this bond supported the weight of two large men without any sign of failure. This new process has been found successful also in attaching rubber to other metals, such as brass and aluminum, also to wood and concrete.

The Vulcalock process requires processing the metal surface by sandblasting or pickling, and the use of a special preparation of the rubber in its uncured form. The pliable, semiplastic gum is applied to the metal and cured in place, and it is during the curing operation that the remarkable adhesion is set up.

The only limiting factor of the Vulcalock attachment is heat, and at present its application cannot be recommended where the operating temperature exceeds 150°F.

Tanks and Tank Cars

The lining of steel tanks, receptacles, and tank cars with soft rubber is proving acceptable in the ceramic, chemical, and allied industries, and rubber is taking the place of less corrosive-resisting and more fragile linings. Railroad tank cars have been lined by the Vulcalock process in sufficient numbers to have developed a standard method for the lining. Special equipment has been provided, and special men have been trained in this class of work. It is desirable to have a tank shell with a smooth, clean inside surface so that the rubber will conform to the metal surface and cure in place with uniform thickness, without any open joints.

The same process has been successfully used for the attachment of tubed or sheet rubber in standard steel pipe and fittings, including special valves. The rubber is so applied that all metal contact is eliminated, giving the pipe a three-fold utility: to resist abrasion, to resist corrosion, and to conduct liquids which are subject to contamination from metal contact. Rubber-lined tanks and pipes will withstand internal pressure corresponding to the strength of the metal. This permits tanks to be discharged and contents transported safely by air pressure, eliminating pumps.

Ball Mill Linings

Limited application has been found for rubber linings in rotary grinding mills. Linings have been in use since 1921. After the first few installations had been made, and the basic principles found to be sound, the development of a commercial lining was considered along two separate lines: first, to produce a standardized lining which could be installed in the field without making any objectionable or costly changes in the construction of the mill, at the same time giving the rubber a positive anchorage in the mill, and eliminating metal from wearing contact; second, to determine the limitations of the lining in regard to varying conditions of operation, so that recommendations could be made to prospective users with some assurance that a saving would result.

It was found that in most dry-grinding operations heat is generated by friction, which sometimes builds up a temperature sufficiently high to cause premature failure of a rubber lining. Rubber linings should not be considered for dry-grinding applications where the temperature exceeds a conservative limit of 150°F. Laboratory and field tests show that severe impact will destroy the structure of rubber and resistance to impact varies in direct proportion to the thickness of the rubber. Therefore, as the size of individual balls which make up a grinding charge increases, a rubber lining must increase in thickness in proportion sufficient to absorb the impact without a damaging effect. From the many tests it has been concluded that the rubber lining is best suited for cylindrical type mills used in the wet-process grinding of fine materials, requiring small balls that give a large grinding surface.

The rubber lining has been used in the Portland cement industry for secondary wet-process grinding to take advantage of the longer life of the rubber, and where comparative tests have been made rubber-lined mills show slightly increased efficiency. Efficiency should take into consideration the combined factors of capacity, fineness, and power consumption, and in the case of the rubber-lined grinding mills, the reduced power consumption is the primary contributing factor in the efficiency equation. Power is saved by reducing the slippage of the grinding media on the shell, and the substantial difference in weight between the rubber lining and steel lining is a contributing factor in favor of the rubber lining.

The rubber lining probably finds an ideal application in ceramic grinding operations because the contamination of white pigments is negligible, and the impervious smooth surface of rubber permits the mill to be washed out clean when color changes are necessary. The construction of some small batch mills used in the ceramic industry permits the lining to be cured into the mill by the Vulcalock process, eliminating all joints and crevices which are objectionable from the standpoint of ceramists.

Some chemical manufacturing operations require pigments to be ground in contact with corrosive liquors. This presents a problem of protecting the interior of the grinding mill from corrosion as well as abrasion. Rubber offers a solution to this combination, and the Vulcalock process makes it possible to line a mill completely without seams, so that corrosion protection is complete and positive.

Cutless Rubber Bearings

Since the inception of the screw propeller on ships, there has been a constant search for a bearing which would satisfactorily carry the load of the propeller shaft under the adverse conditions which always prevail at the stern tube or strut. Many complicated designs have attempted to exclude water and foreign material in order to obtain an oil-lubricated

bearing, but until recently the old standby, lignum-vitæ wood using water as a lubricant, has been accepted as the most practical bearing available for large shafts. This material practically assures a trouble-free bearing for a limited time, but this assurance is obtained only at the expense of a scored shaft liner, frequent and expensive dry docking charges, and severe vibration, which is a serious drawback on passenger vessels.

Within the last few years a new bearing, consisting of a metal sleeve lined with a tough, resilient rubber compound, similar in texture to a good automobile tire tread, has given such phenomenal service when installed in struts and stern tubes in various classes of service that it bids fair to supplant the standard lignum-vitæ construction along with the various mechanical contrivances which have been designed to obtain a metal-bearing surface. Rubber, especially of such a texture as indicated, would at first seem altogether inadequate for such strenuous service, but when it is realized that rubber stands up under such terrific service as it must in a tire tread, its practicability becomes more apparent, especially as the coefficient of friction of wet rubber on metal is very low. Inasmuch as the load is not uniformly distributed over the face of the rubber but varies from zero to a maximum, this allows the lubricating film of water to form at a point of low pressure, which is of great importance owing to its low viscosity as compared with oil. After the film is once formed, it is dragged by its adhesion to the shaft through the length of the face. Once formed, such a film is destroyed with difficulty provided the speed of the shaft does not fall below a very low critical speed.

The superiority of rubber is even more apparent in sandy or dirty water and under these conditions records have been made where rubber has outworn previous installations of babbitt or lignum-vitæ as much as nine or ten times. This comparative immunity to the action of sand is due to the fact that a particle of sand cannot lodge in the rubber and is rolled into the adjacent groove by the shaft where it is washed to the outside of the bearing. Because of this rolling, instead of dragging action, the shaft acquires a highly polished or burnished surface, in contrast to the deeply scored and grooved appearance which it quickly assumes with a hard-surfaced bearing.

A contributing factor to the diminished action of the sand particle is that, with a rubber surface, the unit load on the sand is approximately that of the surrounding rubber, while the unit load on a grain of sand caught between a shaft and a hard-surfaced bearing rises to an enormous value; before it sinks into the bearing or shaft surface it momentarily carries a large proportion of the load of the shaft on its microscopic surface.

While these bearings are becoming most widely known for marine service, there are numerous other applications where they are proving out to show an economic advantage over former practice. One of the most

severe assignments for a bearing is that of supporting a cutterhead on a suction dredge. Rubber bearings are also extensively used on centrifugal pumps, shafting for deep well pumps, and in any submerged location. They are made split or may be installed by the manufacturers in any odd-shaped casting or forging. They have been successfully used on all classes of equipment from hydraulic turbines to passenger vessels, and in sizes from $^1/_2$ inch to 30 inches, inside diameter.

The field of possible application is so broad and intricate that it is practically impossible for engineers in the rubber industry to acquaint themselves with all of the problems involved. It is, therefore, logical to expect that many of the future developments in rubber will come from outside the rubber industry. Progress will, without doubt, be measured by the willingness of engineers to carry on investigations in an effort to produce the old results by new and more efficient methods.

B. F. Goodrich Rubber Co.
Akron, Ohio

VARIOUS METHODS OF TOOLING CONTINUOUS ENAMELING FURNACES[1]

By Paul V. Blackburn

ABSTRACT

The importance of adequate firing tools for handling the various shapes which are enameled in continuous furnaces is discussed. The maximum efficiency of a continuous furnace can only be realized when the conveyer chain is equipped with tools which permit uniform loading throughout its entire length with enough ware to utilize fully the heating capacity of the furnace.

Materials and principles of design are considered and specific tools and racks suitable for various sheet-iron and cast-iron parts are illustrated.

A continuous furnace for enameling should have a firing chamber of long tunnel shape and an endless conveyer chain which carries the enameled ware through the heated chamber. The chain itself should pass over the top of the hot chamber. The enameled ware inside of the furnace should be supported on tools or racks which are suspended from the conveyer chain by means of rods passing through a slot in the top of the heated chamber. Practically all of the continuous furnaces in operation at the present time meet this brief description.

The design and construction of these tools which support the enameled ware have an important bearing on the efficiency of the continuous furnace. When a number of different shapes are to be run through a furnace, tools

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division). Received March 3, 1930.

must be provided which will permit all of the shapes to be conveniently hung or supported.

The design of the individual tools, and the spacing of the tools on the chain should be such that the furnace chain will be loaded to a point which will fully utilize the heating capacity of the furnace. For example, a particular furnace which has sufficient heat input to turn out 3000 pounds of ware per hour at a chain speed of 5 feet per minute is considered; 3000 pounds per hour reduces to 50 pounds per minute. This means that every minute, or every 5 feet of chain travel, 50 pounds of ware should pass through the furnace. Thus, every lineal foot of chain must carry 10 pounds of ware if this particular furnace is to operate at full capacity and maximum efficiency, and proper tools must be provided.

In many cases, it is necessary to tool for a wide variety of shapes. If it is possible to design one tool which will handle all of the different shapes, the routing of the work through the shop will be greatly simplified. The ideal solution, then, to the tooling problem is one standard tool which will take care of all of the different shapes. When this is out of the question, a compromise may be effected by using an assembled or built-up tool with a standard base, and two or more types of attachments. In this way the tools can be readily made over by changing the attachments. This assembled tool with interchangeable parts will be explained in greater detail when particular tools are considered.

Aside from their adaptability to the kind of ware to be handled, the firing tools on a continuous furnace must have certain other qualifications. They must, of course, be made of heat-resisting metal. They should be light in weight and strong. The metal of which they are made should maintain considerable strength under enameling temperatures and must not warp or deform at these temperatures. The tools should also be designed with due consideration for the proper support of each piece of ware and the prevention of the ware warping. Provision must be made to prevent tool marks on the finished ware.

In short, all of the considerations which are involved in the selection of proper firing racks for a box-type furnace apply to the tools for a continuous furnace, with the added consideration that the ware is supported from overhead and that it travels through a narrow chamber, around curves, and, in some cases, up and down an incline.

The tools in the continuous furnace of the incline type must be suspended from the chain at one point only, so that when going up or coming down the incline the supporting rods can be free to swing back and forth and keep the tool and ware level. If the furnace is level, two-point suspension can be used.

The tools must be supported and spaced so as to prevent interference when the chain goes around a curve.

It has been found that in general the most satisfactory material for a continuous furnace tool is a cast alloy with a fairly high content of nickel and chromium. There are some continuous furnace tools in operation made from rolled alloy shapes, welded or riveted together. In most cases, however, castings are preferred. Cast tools can be made lighter than built-up tools of the same capacity. The cost of castings is generally less and the castings possess longer life. Properly designed cast alloy tools will not warp or get out of shape. This last is the greatest objection to tools made from rolled bars and shapes. Unless they are made of very heavy sections, they soon warp out of shape and consequently will not handle the ware without warping it also.

FIG. 1.

In the past, it has not always been possible to design the best tool from theoretical considerations and past experiences. In such cases, the problem could only be solved by experiment. Sample tools were assembled from rolled bars, rods, and angles. These were tried out, changed, and tried out again until the best possible design was determined. The perfected tool was then made from cast alloy. In other cases, whole sets of sample tools were made from cast iron. Practice determined what changes should be made before the tools were cast from the more expensive alloy.

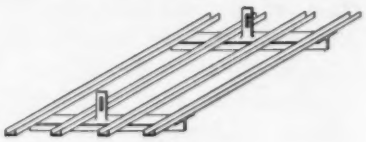

FIG. 2.

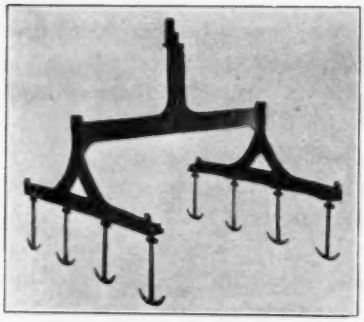

FIG. 3.

At the present time, with so many continuous furnaces operating on practically all classes of work, proper tools can usually be designed by calling on the experience gained from other furnaces.

In considering specific classes of enameled ware and some of the continuous furnace tools which have been made to handle them, the following descriptions and figures are given.

Flatwork, such as table tops and heavy-gage signs, does not present any great problem. The pieces can be hung vertically and because they are of uniform size, the tools are little more than bars with alloy wire "S" hooks for hanging the shapes.

Figure 1 shows a simple tool for flat ware. The pieces are hung by means of alloy wire "S" hooks which are suspended from the hooks projecting from the horizontal bar. This particular tool has quite a wide adaptability in that shapes of various sizes can be handled.

Another tool for signs and flatwork is shown in Fig. 2. Horizontal members are cast alloy channel bars. Hooks supporting the ware are attached to these channels. The "S" hooks made of alloy wire are in general use where the enameled pieces are hung.

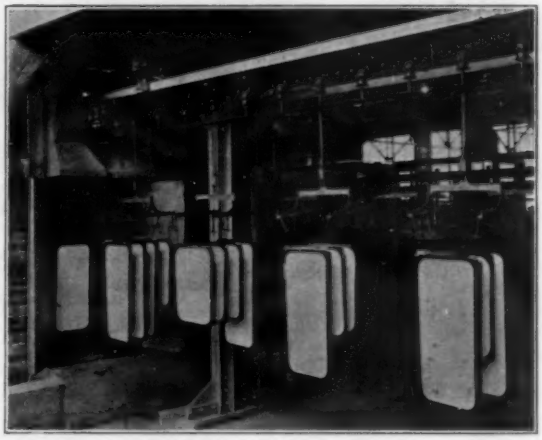

FIG. 4.

Figure 3 illustrates a general utility tool for stove parts for sheet iron and cast iron. The hooks, as well as the bars, are made of cast alloy and hooks are attached with ball and socket joints, which permit the free turning of the hook. This tool is supplemented with wire "S" hooks.

The same tool, loaded with sheet-iron stove parts, is shown in Fig. 4. The furnace shown is tooled throughout with this standard tool.

A firing tool for kitchenware is shown in Fig. 5. This tool is made up of a number of interchangeable supporting castings which are suspended from the chain and from each other by alloy bails. By making these castings interchangeable, points, blades, or tripods can be provided and a great many different kitchen ware shapes handled on the tool.

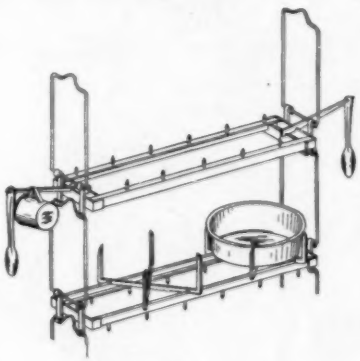

FIG. 5.

In Fig. 6 is shown a furnace chain equipped with racks of this type and loaded with kitchenware.

A special firing tool for washing machine tubs is illustrated in Fig. 7. This tool is made of cast alloy. The supporting rods are triangle bars which may be removed or turned.

Figures 8 and 9 show a tool which was designed for a special job. They also illustrate the principle of using a standard base and interchangeable parts which make up these tools. In this case, it was necessary to handle a general line of stove parts and in addition two special shapes. The first of these was a rather large flat shape which would certainly warp if it were not supported on a number of points. The other shape was a refrigerator liner which could only be properly done lying flat and supported on a number of points.

FIG. 6.

In Fig. 8 is seen the same base rod, attached to which are horizontal cross-rods. These cross-rods are slipped over the base rod and held firmly

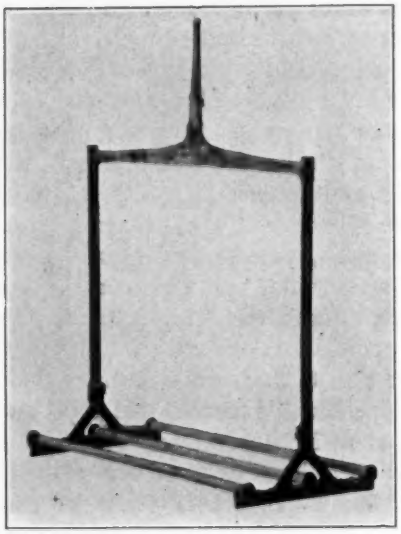

FIG. 7.

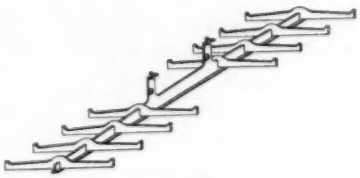

FIG. 8.

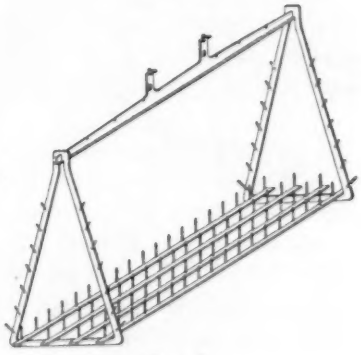

FIG. 9.

in place, due to notches in the base rods. In this form, the tool can take care of all of the stove parts which can be hung. Wire "S" hooks connect the ware to the cross-supports.

Figure 9 shows a third form of this tool. Two of the triangular attachments are used and with them point bars which fit into the recesses. The tool can now be used for firing the refrigerator liners, which will be supported very much as they would be in a box-type furnace.

The tools illustrated here will serve to show how some of the continuous furnace tooling problems have been met. In a sense, each continuous furnace with its particular kind of enameled ware presents an individual problem in tooling; as more furnaces are being installed, however, tools are becoming standardized and less difficulty is experienced in obtaining satisfactory and efficient tools.

FERRO ENAMEL CORPORATION
2100 KEITH BLDG.
CLEVELAND, OHIO

ACTIVITIES OF THE SOCIETY

AMERICAN REFRACTORIES INSTITUTE MEETING

The following program was presented at the Fall Meeting, American Refractories Institute held in Atlantic City, N. J., October 23, 1930.

10:00 A.M. "Manufacture of Refractories in Europe"—Professor R. M. King, Ohio State University.

10:30 A.M. "The Variation in Size of Clay Refractories" discussion on

I. Variation in size of brick and shapes as affecting the laying up or life of refractories in service.
II. Methods of measuring brick and shapes for size and warpage.
III. Causes of variation in size and their control.
(*A*) Moisture content: original and that added: (1) shrinkage, drying, and firing, (2) grind of the mix, and (3) proportion of bond to flint clays.
(*B*) Shaping processes: (1) hand-made, (2) stiff-mud: represses, and (3) dry-pressed: pressure, wear of molds.
(*C*) Sizing: (1) green brick and (2) fired brick.
(*D*) Drying: rate; pallets. Firing: (1) method of setting, (2) rate of, (3) heat distribution, (4) weather conditions, and (5) furnace atmosphere: kind of fuel.

1:30 P.M. "Effect of Forming Pressure on the Properties of Fire Clay Brick." R. E. Birch, Harbison-Walker Refractories Co. (formerly with Roseville Experiment Station, Bureau of Mines).

2:00 P.M. "Insulation of Refractories as the Cause of Spalling." Stuart M. Phelps, Refractories Fellowship, Mellon Institute of Industrial Research.

GLASS DIVISION MEETING AT COVE POINT SUCCESSFUL[1]

It was a unique meeting staged by the Glass Division of the AMERICAN CERAMIC SOCIETY at Cove Point, Maryland, Oct. 4, 5, and 6; nevertheless it was highly successful, both as to business results and pleasure derived. Dr. J. T. Littleton, Jr., chairman of the Division, called the event to order by saying that the objective was to consider important topics and the laying of plans for future work. There was no fixed program. At the various meetings held, however, numerous matters were given consideration. If anyone had a question concerning a certain topic that he wanted to ask about, he was free to do so.

Forty-three went to Cove Point and everyone there benefited. It is hoped that the same type of meeting will be held next year.

One of the first subjects considered was the obtaining of a permanent secretary who would be capable of considering papers contributed by members and decide which ones should be published in the *Journal* of the SOCIETY. The man wanted must, also, understand research problems and edit the papers so that they will be technically correct when appearing in type.

This objective was given quite a bit of consideration early this year and the plan outlined. The thought is to obtain sufficient funds to take care of the expenses that will be incurred.

If every glass manufacturing firm in the United States were to make a small contribution to this work under consideration the industry in general would be materially benefited.

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[1] Excerpts from a report by A. W. Kimes, *National Glass Budget*, Oct. 11, 1930.

It was decided to select a Secretary by vote of the membership at the Annual Meeting, which will be held at Cleveland, next February.

Dr. E. Ward Tillotson of the Mellon Institute, Pittsburgh, read a number of communications concerning subjects that were of interest to the Division. One topic was "A Better Education in Glass." After considerable discussion, it appeared to be the consensus of opinion that the Glass Division did not want to prescribe any curriculum for a university. The discussion seemed to favor a special course in glass in two or three universities in which a laboratory would be conducted, similar to the one so capably handled by Dr. W. E. S. Turner of the University of Sheffield in England.

A communication was read from a correspondence school, favoring a course in glass technology. Comments heard were mostly adverse to this idea.

It was suggested that there should be a number of biographies prepared and arranged of men who have been prominent in the glass business in the United States. In other industries, the accomplishments of the notables have been recorded, but the heroes of the glass industry have not been honored with a biography. An effort is to be made to have biographies written of men who were prominent in developing the glass industry in the United States to its present high state of efficiency.

There was a long discussion as how to arrange the best program for the Annual Meeting of the SOCIETY in Cleveland next February. A majority of those expressing an opinion seemed to favor having at least a dozen papers presented by men who are recognized as being capable, and then follow the presentation of each manuscript by a general discussion.

Dr. G. W. Morey of the Geophysical Laboratory, Washington, D. C., lead in a discussion on "The Constitution of Glass."

Dr. Frank W. Preston of Butler, Pa., suggested holding similar meetings more frequently. Most of the comment on this subject was favorable to the idea, but on account of the large area covered by the glass industry in the United States, it was realized it would be a hard task to accomplish.

Following is a list of a majority of those attending the ceramic meeting at Cove Point:

M. G. Babcock, Pittsburgh Plate Glass Company, Grant Building, Pittsburgh, Pa.
M. L. Begeman, Mississippi Glass Co., St. Louis, Mo.
S. B. Bowman, Hazel-Atlas Glass Company, Zanesville, O.
R. A. Blunt, Buck Glass Company, Baltimore, Md.
Mr. Diffendeefer, Carr-Lowrey Glass Company, Baltimore, Md.
A. N. Finn, Bureau of Standards, Washington, D. C.
F. C. Flint, Hazel-Atlas Glass Company, Washington, Pa.
J. F. Gillinder, Gillinder Bros., Port Jervis, N. Y.
J. F. Greene, Kimble Glass Company, Vineland, N. J.
C. Hahner, Bureau of Standards, Washington, D. C.
Henry Helmers, Cambridge Glass Company, Cambridge, O.
E. L. Hettinger, Willson Products, Inc., Reading, Pa.
Phillip Heuisler, Jr., Maryland Glass Corporation, Baltimore, Md.
C. R. Hilgenberg, Carr-Lowrey Glass Company, Baltimore, Md.
C. G. Hilgenberg, Jr., Carr-Lowrey Glass Company, Baltimore, Md.
J. C. Hostetter, Corning Glass Works, Corning, N. Y.
H. Insley, Bureau of Standards, Washington, D. C.
A. W. Kimes, *National Glass Budget*, Pittsburgh, Pa.
R. Lester, Maryland Glass Corporation, Baltimore, Md.
J. T. Littleton, Corning Glass Works, Corning, N. Y.
G. E. F. Lundell, Bureau of Standards, Washington, D. C.
A. Lyle, Hazel-Atlas Glass Company, Washington, Pa.
G. E. Merritt, Bureau of Standards, Washington, D. C.
J. J. Moran, Kimble Glass Company, Vineland, N. J.
C. B. McComas, Carr-Lowrey Glass Company, Baltimore, Md.
G. W. Morey, Geophysical Laboratory, Washington, D. C.

C. G. Peters, Bureau of Standards, Washington, D. C.
F. W. Preston, Butler, Pa.
R. C. Purdy, AMERICAN CERAMIC SOCIETY, Columbus, O.
L. C. Roche, Maryland Glass Corporation, Baltimore, Md.
S. R. Scholes, Fostoria Glass Company, Moundsville, W. Va.
E. Schott, Jena Glass Works, Jena, Germany.
D. D. Schurtz, Sharp-Schurtz Company, Lancaster, O.
L. T. Sherwood, Pennsylvania Wire Glass Company, Philadelphia, Pa.
G. O. Smith, Carr-Lowrey Glass Company, Baltimore, Md.
C. D. Spencer, National Lamp Works, Cleveland, O.
E. W. Tillotson, Mellon Institute, Pittsburgh, Pa.
M. F. Van Dusen, Bureau of Standards, Washington, D. C.

LOCAL SECTION NEWS

California Section

The regular quarterly meeting of the California Section of the AMERICAN CERAMIC SOCIETY was held on Monday evening, Sept. 8, 1930, at the Engineers Club. Seventy-five members and guests were present.

The program consisted of the following papers: "Color in Architecture," by Julian Garnesy, a mural painter; "Glaze Fitting on Ceramic Bodies," by A. Malinovszky of the Washington Iron Works; and "Production of Porcelain," by Herman Coors of the H. T. Coors Co., Inc.

Entertainment was furnished by Norman W. Kelch of the Clay Products Institute and Robert Linton of the Pacific Clay Products Co.

Pittsburgh Section[1]

A meeting of the Pittsburgh Section of the AMERICAN CERAMIC SOCIETY was held on Tuesday evening, October 14.

Erwin Sohn, Director of Research, Standard Sanitary Manufacturing Company, presented a comprehensive address on "The Enameling of Iron." The different types of enameling were fully covered and several of the more interesting problems discussed.

The following members and guests attended: Robert C. Boyd, Earl E. Petrie, James R. Beam, Geo. R. Daniel, Fred Sauereisen, Jno. Coulter, P. D. Helser, Robert F. Ferguson, L. R. Kirk, Ed. L. Harcourt, Frank L. Jones, C. M. Franzheim, R. E. Birch, Theo. Lenchner, Fred S. Thompson, H. W. Baque, E. J. Casselman, Louis A. Smith, J. S. McDowell, Fred A. Harvey, R. E. Stark, S. M. Swain, W. Keith McAfee, L. E. Whitesell, B. C. Ruprecht, D. M. Staley, W. F. Wenning, F. H. Kohne, L. E. Thomas, Erwin Sohn, and Louis Probst.

SALUTE TO VITREOUS ENAMELING INDUSTRIES, OCTOBER 7, 1930

From KDKA Westinghouse Station

BY GENERAL EDWARD ORTON, JR.

You have heard from the other speakers something of the wide scope of the porcelain enamel industry which is bringing so much to you in the way of comfort and beauty in its products. Perhaps you would like to hear something from me about what porcelain enamel really is and how it is made.

[1] R. C. Boyd, *Secretary*.

A true enamel is a glass-like body fused upon the surface of a metallic base. All glasses are composed of mineral matter only, and are made by melting the ingredients together in the glowing heat of the furnace, and when once made, there is nothing left which can be destroyed by heat. Enamels differ from all paints, varnishes, lacquers, and similar surface finishes which are organic in base and are easily affected by heat. They lack the hardness, wearing quality, and resistance to solvents, which true enamels possess in high degree. So please get that distinction clear in your minds. When you desire an enamel product, be sure that you are getting a true vitreous enamel, and not a paint or an organic surface coating.

Vitreous enamels are principally applied to sheet iron or steel, or to cast iron; in less degree to the rarer metals such as copper, gold, or silver. Sheet-iron enameled goods comprise the great group of household utensils, hospital sanitary supplies, and glass-lined tanks and containers, such as are used to transport milk and chemicals. The cast-iron products comprise the stoves, sinks, bath-room tubs and other fittings, refrigerators, and other heavy goods. The third group comprises the beautiful enamels used in jewelry, watch dials, and art ware. The technique for making each of these is different.

After a metal object has been fashioned, the first step is to make the metal surface chemically clean, in order that the enamel may adhere and become almost an integral part of it. In sheet iron or steel ware, this is accomplished by pickling or immersing the article in acids which eat away all oxide and dirt, leaving the metal bright and silvery in appearance. Large cast-iron objects are etched or cleaned by sandblasting. These two methods also reveal any flaws or imperfections which must be repaired before the enamel is applied.

The enameling of the prepared metal surface begins with the application of a base coat. This forms the bond between the metallic surface and the subsequent glossy finishing coats. The base coat is fundamentally a glass, but it contains some elements designed to make it bite into the metal surface and form almost an alloy with it. When fused, it protects the metal surface from oxidation and cannot be detached from it. It also provides a transition layer between the pure metal beneath and the pure glass above, and partakes somewhat of the properties of both. Without a good base coat, no enameled product will be good. Hence an enormous amount of research has been expended by enamelers on base coats.

Now, what is the vitreous enamel, itself? I have already said that it is a glass. Everybody knows, in a general way, that glass is made by melting minerals together, until the whole mass becomes a clear limpid liquid, with a temperature of around 2000 degrees. This liquid, while still plastic, is formed into hollow receptacles like bottles, into sheets like window glass, or into solid objects. The glass then hardens into the solid, durable body with which you are familiar.

Where an enamel, as a very thin layer of glass, is to be fused upon the surface of a metal, it must be done quickly or the metal may warp, get out of shape, or oxidize. Hence, the enamel glass has to be melted in a furnace into a perfect liquid, and then run out into water which crackles it into small grains like sand. This is called frit. The frit is then ground to a fine powder for cast-iron enameling, or ground wet into a thin smooth creamy liquid for sheet-iron enameling. Since all the chemical changes involved in making the glass are performed in the frit furnace, the refusion of the minute grains of frit on the metal surface is a short process. The coloring matter, used so successfully in recent years, is also mineral in nature, and has to be fused into the glass, so that it is really a part of the enamel and can never fade or wear off.

After the base coat has been applied to the metal, it may be fused by a first application of heat, after which the finishing coats, two or more, are applied and fused into

glossy surfaces by two or more heatings. Or in other branches of the industry, the base coat and finishing coats may be applied one at a time, and dried on, and then the whole composite layer be developed in one furnace treatment.

Great skill is required in firing the enamel onto a metal object, so that the metal itself shall not be deformed or injured, and still use heat enough to fuse the powdered frit into a perfect and flawless sheet of glass. Modern inventive genius has so perfected this process, and the scientific instruments for controlling the operations are so accurate, that the elements of guesswork or judgment are almost eliminated. Research laboratories are constantly busy testing materials and checking operations at every stage, for which trained ceramic chemists and engineers are employed.

The art of producing enamel products has now reached the stage where the smoothness and precision which characterizes American mass production is fully exemplified. Enamelers are constantly extending their products into different fields and are making special enamels to fit any condition which modern industry may require.

As you continue to use these daily conveniences which are now necessities in every American home, you will do so, with an added appreciation of the service which this great industry is rendering.

LETTERS FROM OUR SECRETARY

2525 N. High St.,
Columbus, Ohio
October 15, 1930

Your Society—What About It?

Dear Fellow Member:

The increasing number of letters in testimonial of high value placed on the reports of original investigations and on the *Abstracts* which appear each month, give assurance that the work of the members through this, their collective agency, is of vital importance to the ceramic industries.

The members who are not participating in Committee activities and meetings are missing effective opportunities for their self-improvement. Merely receiving the *Journal* and *Abstracts* does not bring a member the fullest possible benefits which can be accrued from this coöperative organization.

We wish to make some suggestions:

(1) Give assurance to your Divisional Program Committee that you will attend and participate in the Meetings. Present a paper or a discussion. The Divisional Committees are going to restrict their programs to papers most worth while so as to conserve the time of the attending members. It ought to be an incentive to see if you can get your paper and discussion into the program.

(2) The Ceramic Exposition, held in connection with the Meeting, is an educational opportunity for you and for the citizens of America. It is imperative that we make our fellow citizens fully acquainted with the high character and industrial value of ceramics so that we may obtain larger legislative support of research investigations in our several state schools and federal bureaus.

(3) The ceramic industries are surely learning that their research staffs must be employed in the sales, as well as in the production departments. The laboratories now have definite sales objectives. It is for this reason that the American Ceramic Congress in Cleveland next February is of vital importance to you.

(4) The SOCIETY has not increased its financial revenues apace with the increase in demands and opportunities for service. The number of reports of original investigations submitted for publication is increasing, as are the *Abstracts*. This means an increase of expense. The SOCIETY must have a larger income.

Next year the personal dues will be $12.50. This increase in dues, however, will not cover the increase in cost of operations, even with the most exacting economy in the secretarial and editorial offices. It is imperative that each member of the SOCIETY shall solicit personal and corporation memberships.

(5) There are enough ceramic corporations operating in the United States who could comfortably pay $25.00 a year to make the SOCIETY financially able to care for the increasing opportunities which come to it for service. Many corporations are not supporting the SOCIETY simply because they have not been personally solicited. This is up to you.

(6) Nonceramic competitive products are increasing in numbers and their producers are hot after the market. They must be met on the basis of quality and cost.

There is only one way to improve quality and to decrease cost, and that is through research. The most effective research is that which is done in collaboration. Problems are solved more quickly and progress more assuredly made when there is an effective association of researchers. You can make this coöperative organization more effective by participation in the Meetings, the Exposition, and in the securing of additional membership support.

What the American Ceramic Society Means to You

My dear Fellow Ceramist:

For thirty-one years, men have been federated together in this organization for the purpose of advancing the art, science, and technology of the clay, glass, and vitreous enamel industries. In the beginning, their considerations were limited to the academic problems of ceramic ware production. The competition of non-ceramic products and the increase in diversity of uses of ceramic ware have broadened the field of the ceramic artists, scientists, and technologists until today the research laboratory is on the firing line with the sales department. Ceramic technologists are thinking in terms of ceramic products.

The trade associations are no longer competent unless they are doing research work on the product which they represent. It is as essential to their welfare and to the welfare of the ceramic industries that their technical society shall be able to meet the demands for new information, new processes, new compositions, and new uses of products as it is for the trade associations to meet trade competition.

The American Ceramic Society Committees are developing problems, gathering information, publishing results of researches, and abstracting all of the current literature of importance to the ceramic industries. They are focusing the attention of a large number of research laboratories in our schools and governmental institutions on your problems, with the result that today you can manufacture more economically under better control, and produce higher quality of product.

You are asked to participate in this work.

Personal memberships for 1930 are $10.00 and for 1931 they will be $12.50. Corporation memberships are $25.00, the corporation members having full voice and control the same as active members. Since it is the companies that benefit directly from the activities of this organization, it seems fitting that they should support it through corporation memberships.

A sample copy of the monthly publication will be mailed on request.

We shall be glad to enroll you with the 2500 individuals and the 300 corporations who are now supporting this SOCIETY.

Letter to Prospective Advertisers

Your product is used in the clay, the glass, and the enamel ware industries, collectively known as the ceramic industries.

You want a coöperative friendship with the men in each of the ceramic plants who make the decisions on materials and equipment to be used.

Coöperative friendship? Sure thing! A friendship founded on mutual benefits. Personal appreciation of you, as well as of your product, is essential in getting business.

The *Journal of the American Ceramic Society* is owned by and operated in coöperation with the men in the ceramic plants who decide on the materials and equipment to be used in their plants.

Your advertisement in their *Journal* is read by the man you most desire to reach and you are at the same time reaching him on a coöperative friendship basis.

Yours very cordially,
Ross C. Purdy, *General Secretary*

NEW MEMBERS RECEIVED FROM SEPTEMBER 1 TO OCTOBER 1

PERSONAL

Oran K. Edwards, 160 Mill St., Portland, Ore.; Manager, Willamina Clay Products Co.
G. Milton Ehlers, 515 Garfield Ave., Milwaukee, Wis.; Chemical Engineer, Globe-Union Mfg. Co.
Frank Paul Henderson, 226 Winnipeg Ave., San Antonio, Texas; Manager, The Southern Co.
Herbert W. Kochs, 53 W. Jackson Blvd., Room 414, Chicago, Ill.; Secretary, Diversey Mfg. Co.
C. Genevieve Lawlor, H.O.J. Pottery, 926 Arcade at Vernon Ave., St. Louis, Mo.
Mary Ruth Lionberger, H.O.J. Pottery, 926 Arcade at Vernon Ave., St. Louis, Mo.
C. B. Stahl, Sherman St., White Hall, Ill.; President and Gen. Mgr., White Hall Sewer Pipe & Stoneware Co.
Walter P. Suter, Designer and Sculptor, American Encaustic Tiling Co., 16 East 41st St., New York, N. Y.
Virgil Henry Waite, Box 83, Elyria, Ohio; Director of Research, McGean Chemical Co.

STUDENT

University of Illinois, Urbana, Ill.

George T. Moore — **Loren Arthur Trabert**

N. Y. State School of Clayworking and Ceramics, Alfred, N. Y.

Henry W. Ellison — **LaVerne A. Messimer**

Iowa State College, Ames, Iowa

Guy Eugene Stong

Membership Workers' Record

PERSONAL		STUDENT	
B. M. Burchfiel	1	Charles R. Amberg	2
F. E. Hodek, Jr.	1	A. I. Andrews	2
Henrietta O. Jones	2	D. A. Moulton	1
C. D. Spencer	1		—
George Tyler	1	Total	5
Office	3		
	—		
Total	9	Grand Total	14

ROSTER CHANGES IN SEPTEMBER

PERSONAL*

Bennett, Dwight G., Metal & Thermit Corp., 120 Broadway, New York, N. Y. (628 Cleveland Ave., Elizabeth, N. J.)

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* Addresses within the parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be secured from the Secretary's office, price $2.00.

Blake, A. E., 207 Malvern Apts., 93 Seward St., Detroit, Mich. (1115 Dickinson Rd., West Brookline, Pa.)
Brannon, W. F., Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. (124 Elizabeth, Atlanta, Ga.)
Brauer, W. L., A. J. Lindemann & Hoverson Co., Milwaukee, Wis. (Ames, Iowa.)
Cross, James A., Robinson Clay Products Co., Mogadore, Ohio. (388 Reinhard Ave., Columbus, Ohio.)
Curtis, C. E., Matanuska, Alaska. (Univ. of Washington, Seattle, Wash.)
Eddy, Allerton, 33 W. Washington St., Newnan, Ga. (Southern Natural Gas Corp., Birmingham, Ala.)
Grady, John H., Winkle Terra Cotta Co., 5739 Manchester Ave., St. Louis, Mo. (National Fireproofing Corp., E. Canton, Ohio.)
Grout, J. R., Jr., B. Mifflin Hood Brick Co., Daisy, Tenn. (Route 3, Danville, Ill.)
Hainsfurther, R. M., Pittsburgh Plate Glass Co., Pittsburgh, Pa. (912 Lock St., Tarentum, Pa.)
Hellmers, Henry T., 428 North 10th St., Cambridge, Ohio. (213 Waverly Way, Clarksburg, W. Va.)
Johnson, Glenn W., General Electric Co., Pittsfield, Mass. (427 8th Ave., Grinnell, Iowa.)
Kimes, Arthur W., *National Glass Budget,* Rooms 405–406, 313 Sixth Ave., Pittsburgh, Pa. (426 Fourth Ave.)
Meyer, Herbert T., Porcelain Enamel & Mfg. Co., Baltimore, Md. (Box 3051, Raleigh, N. C.)
Meyer, Theo., Norton Company, Worcester, Mass. (204 Welch Ave., Ames, Iowa.)
Miller, John B., Pittsburgh Plate Glass Co., Mt. Vernon, Ohio. (706 W. Washington, Urbana, Ill.)
Moncrieff, James W., 1476 Worthington St., Columbus, Ohio. (627 W. 22nd St., Anderson, Ind.)
Ross, William E., Alfred, N. Y. (217 E. Ontario St., Chicago, Ill.)
Rupp, Edwin M., 359 Armstrong Ave., Peru, Ind. (13 E. Maple, Mt. Healthy, Ohio.)
Scripture, Edward W., Jr., 3159 Euclid Heights Blvd., Cleveland Heights, Ohio. (Aluminum Co. of America, New Kensington, Pa.)
Stolte, Norman H., Dept. of Ceramic Engineering, N. C. State College, Raleigh, N. C. (Alfred, N. Y.)
Stone, F. R., Canadian Potteries, St. Johns, Quebec. (537 Sherbourne St., Toronto, Ont., Canada.)
Tait, Leonard G., Box 555, East Liverpool, Ohio. (656 N. 15th St., Sebring, Ohio.)
Taylor, William N., 56 Acton Rd., Columbus, Ohio. (231 Huron St., Toledo, Ohio.)
Thomas, Robert R., Jr., Harshaw Chemical Co., Chicago, Ill. (East St. Louis, Ill.)
Underwood, C. A., 67 Foster Road, Belmont, Mass. (113 Van Nostrand Ave., Englewood, N. J.)
Westall, Charles C., Pittsburgh Plate Glass Co., Pittsburgh, Pa. (912 Lock Street, Tarentum, Pa.)
Williams, George A., Piffard, N. Y. (15 Remsea Ave., New Brunswick, N. J.)

NOTES AND NEWS

COÖPERATION OPPORTUNITY

The following letter was received October 10 from Colin G. Fink, Secretary of the American Electrochemical Society:

Dear Mr. Purdy:

The American Electrochemical Society is devoting one of its sessions at the coming Spring Meeting to be held at Birmingham to "Electrochemistry and Ceramics." We are extending to the members of your SOCIETY a very cordial invitation to attend this session and to actively participate in the discussion.

Furthermore, we should be very much delighted to receive from one or more of your members manuscripts on certain phases of ceramic art of particular interest to electrochemists and electrometallurgists.

We should consider it a favor if you will announce this Meeting of our Society, to be held in Birmingham, April 23, 24, and 25, 1931, to the members of your SOCIETY, urging them to submit their manuscripts not later than the 15th of February.

CERAMIC SCHOOL NOTES

New York State School of Clayworking and Ceramics

The New York State School of Clayworking and Ceramics opened on Monday, September 22, with the following faculty: Charles F. Binns, Director, *Department of Engineering:* Charles R. Amberg, Professor of Ceramic Engineering; Murray J. Rice, Professor of Ceramic Chemistry; Clarence W. Merritt, Associate Professor of Ceramics; Warren P. Cortelyou, Assistant Professor of Chemistry. *Department of Applied Art:* Marion L. Fosdick, Professor of Ceramic Art; Clara K. Nelson, Professor of Drawing and Design; Charles M. Harder, Assistant Professor of Drawing and Ceramic Art; and Erma B. Hewitt, Instructor in Metal Work as applied to Pottery.

There are 182 students registered; 116 in engineering and 56 in applied art.

Two graduates of last June, Dorothy Hallock and Frances Greene are doing special work in the Ceramic Guild of the Art Department.

The Trustees of Alfred University held their annual meeting during Commencement Week and appointed three new members to the Board of Managers for the Ceramic School. The Board now comprises the following: B. C. Davis, President of Alfred Univ., John J. Merrill, Albany, N. Y.; B. S. Bassett, W. R. Clarke, and D. S. Burdick, of Alfred, N. Y.

The new members of the Board are as follows: Amory Houghton, Member of Board of Directors, Corning Glass Works, Corning, N. Y.; R. H. Pass, President, Pass & Seymour Co., Inc., Syracuse, N. Y.; and Richard F. Dalton, President, New York Architectural Terra Cotta Co., Long Island City, N. Y.

In July this Board of Managers held its first meeting. Mr. Pass was represented by Dr. Schramm and Bruce Thorngate of the Onondaga Pottery Co., Syracuse. The meeting was held for the purpose of discussing plans for the new ceramic building with the Director of Education of the State of New York, Dr. Lewis A. Wilson. Tentative plans were drawn up which are now being worked over and made ready for execution.

Iowa State College

The Department of Ceramic Engineering at Iowa State College began its 1930–1931 college year with the largest freshmen enrollment in its history, a total of 15. The upper classes are weak in enrollment, which is regarded as a rather happy circumstance because of the business depression.

The men, sixteen in number, who graduated last June were all successfully placed and all report agreeable surroundings and pleasure in the work they are doing.

Several new pieces of equipment have been added or are being ordered; notably, a commercial-sized auger machine is being placed with an arrangement for altering

the speed of the machine at will when it is in operation, and a potter's lathe for finishing fine art pottery has been installed, this being quite different from the usual potter's lathe and designed by members of the staff and built in the Department of Mechanical Engineering in the machine shop. This lathe is peculiarly suitable for work by the art potter and the schools teaching the clay crafts.

The faculty had two changes, George M. Petersen replacing Mary Lanier Yancey as professor of Pottery Decoration and Design. Professor Petersen has two degrees, one in Landscape Architecture and the other in Ceramic Engineering, and in addition, he has done a considerable amount of extra work in drawing and design. On Professor Petersen will fall the burden of the major instruction in the new four-year course in Ornamented Ceramics.

C. G. Harman takes over the work in research, coming to Iowa State College from the University of Illinois, and he has a number of projects which are backed by the Engineering Experiment Station under way already.

Professors Cox, Moulton, and Harman will work on an extensive investigation concerning the buff-firing clays of Iowa, and the resulting bulletin will cover all of the possible uses and all of the properties of these abundant clays of the state. The major investigation on this project will be to determine the value of Iowa clays for chemical stoneware. An investigation of this sort is one looking to the future rather than the present.

In the classes in avocational pottery, the enrollment is up to the usual standard and prospects are good for the usual two hundred individuals who take the work, coming in from other departments on the campus.

Additional furnaces and test kilns will be constructed in the course of the year and several pieces of minor equipment are being brought along by the staff members.

A number of alumni who have been out for quite a while in industry have agreed to talk before the Student Branch of the AMERICAN CERAMIC SOCIETY, which has its meeting scheduled regularly once a week during daylight hours, a place on the college calendar being provided for it.

"Ames Pottery Made from Iowa Clays" has been displayed for the past year by the General Federation of Women's Clubs, by the Iowa Federation of Women's Clubs, and by several consignment agents. The sales have been satisfactory and the advertising benefit to Iowa and its clay resources have been of great value.

Work has been started already by the students for the annual Veishea or all-campus festival, which occurs in the spring, and the young men are pushing on this work because of outside interest in what they are likely to do and requests concerning their activities which have always been of the greatest interest to people in and out of Ames.

D. A. Moulton was employed on the Industrial Survey of Iowa during the summer months, studying the ceramic products now being manufactured, probable raw materials not now being used, markets for ceramic industry now in operation, and those

that might be induced to embark in the business. This survey is under the direction of Prof. F. D. Paine, personnel officer of the Engineering Division, and ultimately an extensive report will be available for interested persons, but this report will first be presented to the General Assembly of the State of Iowa for its approval and action.

The Department of Ceramic Engineering is coöperating with two or three clay industries that are in process of development and these are of a nature not competitive with any type of clay product now being manufactured.

Prospects for a successful year on the part of both the ceramic engineering students and the clay industries of Iowa are bright.

Wednesday evening, October 15, at the Memorial Union, the upper classmen in the Department of Ceramic Engineering entertained the freshmen and the new students who have come from other institutions to the department. This is an annual affair and as has always been the case, proved to be a pleasant way for the students to become acquainted with one another.

The faculty of four and the two men enrolled in the four-year course in Ornamented Ceramics and one guest student enrolled in Geology but taking quite a bit of work in Ceramics were the leaven in the mass of Ceramic Engineers. Brief talks of the usual banquet style were made by Professors Cox, Moulton, Harman, and Petersen and the president of the Student Branch of the AMERICAN CERAMIC SOCIETY, Dan Cherry, was toastmaster. The freshmen have been appreciative in their pleasure of the entertainment afforded them by the upper classmen.

West Virginia University[1]

Colonel Elwood Jones of Switchback, West Virginia, has given ten Research Fellowships to West Virginia University, each paying $1200 per year. The College of Engineering has received three of the fellowships, two being in the Department of Chemical Engineering. One of the Fellowships in Ceramic Research has been granted to D. D. Wheeler who received the degrees of Bachelor of Science in Ceramic Engineering in 1928 at Iowa State College, and Master of Science in Ceramics in 1929 at the University of Washington. He spent six weeks as Graduate Assistant at the Massachusetts Institute of Technology in 1929. Since then he has been in the Enamel Research Department of the American Rolling Mill Company.

C. J. Potter, who is carrying on a coal carbonization investigation under a Jones Fellowship, received the degrees of Bachelor of Science and Master of Science in Chemical Engineering from the Missouri School of Mines in 1929 and 1930, respectively.

CERAMICS AT THE IOWA STATE FAIR

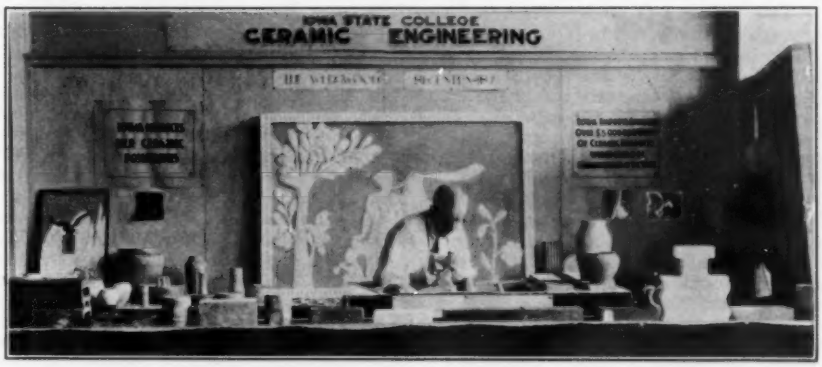
Ceramic work was well represented at the Iowa State Fair during the last two weeks of August.

The brick and tile manufacturers of the state had their usual fine showing of their products built into silos, hog houses, and general farm buildings. Dealers in fine ceramics had well-arranged displays, and these represented all sorts of goods, from cheaper

[1] W. A. Koehler, Professor of Chemical Engineering.

tableware in both clay and glass, to the finest things in tableware and the floor- and wall-tile products. A trip through the various buildings showed that Iowa is becoming ceramically conscious at a rapid rate.

The potter's wheel was unusually in evidence. The Artclay Co., of Scranton, Iowa, is operating a small plant on the production of art pottery, with the present plant intended to serve as a promotional one. A corporation is being formed at this time to increase the production. They had two men working on wheels during the entire fair, and were located up in the building known as Exposition Building. Crowds of people watched the men at work all day long. One of the two men worked with a power wheel and for the most part made stoneware forms.



The Department of Ceramic Engineering of Iowa State College had the display shown in the photograph. This was in the Educational Building where all of the Board of Control and Board of Education institutions, together with the 4-H Clubs, public schools, and endowed colleges display themselves.

The reproduction of the Wedgwood tile in the proper colors backed up the show and the display was made up of the sort of ceramic products that would cause visitors to ask questions. The Wedgwood tile was shown because of the Bicentenary Celebration of Wedgwood's birth being celebrated this year. The wheel drew the interest of the visitors and made it possible to tell the citizens something about the fields of ceramics.

TWO LETTERS TELLING THAT BRICK ARE COMING TO THEIR OWN[1]

(1) Here Are Some of the Willingness-to-Certify Plan Which Cannot Help but Encourage the Entire Industry

Some very interesting results have already been obtained in testing members' brick at the National Bureau of Standards. These tests and the results thereof may become the means of entirely dispelling many antiquated ideas regarding the strength of brick and brick masonry. Moreover, we are convinced from the tests made so far that we will probably be enabled to establish even higher grades than "A" brick in specifications and thereby obtain preferential building code provisions for use of "AA" brick or, perhaps, "AAA" brick.

[1] Members' Weekly News Letter, No. 510, Common Brick Manufacturers Assn. of America, August 16, 1930.

The brick industry as a whole, would be sadly delinquent in its duties and opportunities if it did not capitalize the findings of the nationwide investigation now under way to determine the strength of commercial brick available in all parts of the country. Imagine for the moment what substitutes for brick might do if they could authoritatively establish that the strength of their products were two, three or even four times stronger than the general belief, and many times stronger than the code-writing authorities are assuming. The brick industry stands today in this enviable position.

Out of 85 sets of clay and shale brick samples already tested and reported upon, 5 sets ran better than 15,000 lbs. per square inch in compressive strength; 18 sets ran better than 10,000 lbs. per square inch, and a total of 58 sets were better than 4500 lbs. per square inch. The requirements for grade "A" brick is 4500 lbs. per square inch and, yet, almost 75% of the samples so far submitted greatly exceeded these requirements. In general, then, clay and shale brick far surpass any competing material in strength—and in this fact every brick manufacturer should take considerable pride.

Twenty-one sets of samples were below 4500 lbs. per square inch in compressive strength and only 6 sets (admittedly salmon brick) developed less than 2500 lbs. per square inch in compressive strength. (2000 Lbs. per square inch strength for concrete is usually considered fairly good concrete.)

In a recent appearance before the United States Department of Commerce, we were unable to disprove the statement that the strength of common brick generally available throughout the country averaged better than 2000 lbs. per square inch. The brick industry was, in effect, challenged to prove that brick averaging better than 2000 lbs. per square inch existed generally, and the action of the code-writing committee indicated that, in their opinion, a brick of 2000 lbs. strength represented the average. In the light of what the 85 tests have proven, authoritatively and officially, we are now in a position to substantiate our claims for a considerable raise in allowable working stresses for brick masonry. With this explanation of the tremendous value attached to every member submitting brick for tests to substantiate and bolster our arguments, can there still be a reason for any member not sending his brick to Washington for tests? If there is reluctance on the part of a member to have his brick tested, please communicate with us and give us the opportunity of removing the doubt from your mind. So far approximately two-thirds of our membership have not yet sent samples for tests.

Another important development of the tests at Washington has been to establish definitely that efflorescence in brickwork is only rarely due to the chemical contents of the brick itself. Very delicate tests of all the samples of brick submitted have been made to detect efflorescence and, so far, of the great number of brick tested, only one or two instances have been found where soluble salts existed in the brick themselves. This information will be extremely helpful to the industry.

Sample Displays Jordan Pugh, our Washington representative, makes the following suggestion:

"Marble, limestone, and face brick are on display in the Sample Room of the Supervising Architect of the Treasury. Very little common brick is on display. There has been a tendency to design, especially the smaller post offices, with a color range of brick which might well be selected from common brick. If members will send samples of their facing brick here and such brick seem to fit the design for any particular post office, specifications can then be written around these brick. This does not necessarily imply that the brick will be used, but it opens up an opportunity that might not otherwise occur."

In view of the huge government construction program now under way, it is strongly advised that members who make a facing brick take advantage of this suggestion and send samples of their brick for display purposes. Manufacturers interested in this matter should communicate with Mr. Pugh regarding the shipment of samples before they are made.

J. J. Stein, *Assistant Manager*

Brick Tests Disclose Important Information

The testing of members' brick at the National Bureau of Standards has already developed some interesting and important results.

Up to September 1, 1930, nearly 100 plants had sent in a total of about 1850 speci-

mens, representing, roughly, 300 grades of brick. We have received reports on 233 "grades" of brick which have all been tested in accordance with the methods specified by the American Society for Testing Materials.

Complete analyses of the results will be made and reported later, but a compilation of the compressive strength values is sufficiently gratifying to merit some mention here. The results may best be visualized from the following table of 233 grades (represented by not less than 5 specimens for each grade, in some cases 15 specimens). The number of samples which developed compressive strength of from:

1000	to	2000	lbs.	per	sq.	in.	was 15
2000	"	2500	"	"	"	"	" 9
2500	"	3000	"	"	"	"	" 14
3000	"	3500	"	"	"	"	" 22
3500	"	4000	"	"	"	"	" 21
4000	"	4500	"	"	"	"	" 14
4500	"	5000	"	"	"	"	" 15
5000	"	6000	"	"	"	"	" 27
6000	"	7000	"	"	"	"	" 18
7000	"	8000	"	"	"	"	" 20
8000	"	10,000	"	"	"	"	" 21
10,000	"	15,000	"	"	"	"	" 29
15,000	"		"	"	"	"	" 8

It should be remembered that our instructions asked all members to submit samples of "salmon" brick for test, whether they sold them or not. Twenty-one (21) grades in the lower strength classes were admittedly salmon bricks, and there may have been others not so identified. So that nearly every sample of merchantable brick submitted for test developed an average compressive strength of 2500 lbs. per sq. in., or better. And note to what figures these "better" strengths ran. Thirty-seven (37) grades, over 10% of the total, were better than 10,000 lbs. per sq. in. Eight grades were better than 15,000, and one grade each, from Pennsylvania and Kansas, developed strengths of nearly 20,000 lbs. per sq. in.

This significant fact is clearly proven: the conception of the strength of brick throughout the country has, in the past, been entirely erroneous because it was much too low. The Department of Commerce Building Code Committee, who had access to about all available data in formulating their recommendations for masonry wall construction (1925), based working stresses and other provisions on the "medium" grade of brick, as described in the older A.S.T.M. specifications (now superseded). This medium grade was based on an average compressive strength of 2000 to 3500 lbs. per sq. in. They must have doubted the existence of many grades or samples above this grade, for they said—"It is reported, however, that several localities are using successfully a thoroughly fired brick with high compressive strength and absorption considerably exceeding the A.S.T.M. limits for 'medium brick.' "

The results tabulated above are from plants in 19 different states, from Washington to Virginia and from Wisconsin to Texas. They may be reasonably accepted as representing a fair example of the country's production. And so, even including the salmon grades, we find that only 25% of all samples were of "medium" or poorer grades.

If we exclude the salmon samples, only 39 out of 233 grades, or 16.5% were of medium or poorer grade. Hence 83.5% were better than the medium grade.

It is interesting to observe that 138 out of 233 grades are grade "A" bricks, measured by the present standard A.S.T.M. specifications. And the number of grades having strengths above 8000 pounds would strongly indicate the necessity for other higher grades being inserted in that specification, for 58 grades (25%) were better than 8000 lbs. per sq. in. in compressive strength.

When we recall that brick of other materials than clay or shale rarely reach a maximum strength of 4000 lbs., and that concrete brick average even less (often as low as 1000–1500 lbs.), we may well take pride and satisfaction in this proof of clay brick superiority.

L. B. Lent, *Chief Engineer*

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 29, 1930 to January 3, 1931	Cleveland, Ohio
AMERICAN CERAMIC SOCIETY	February 22–28, 1931	Cleveland, Ohio
American Concrete Institute	February 24–26, 1931	Milwaukee, Wis.
American Electrochemical Society	April 23–25, 1931	Birmingham, Ala.
American Face Brick Assn.	November 12–14	Asheville, N. C.
American Mining Congress Annual Convention	December 1–6	Washington, D. C.
American Society of Mechanical Engineers	April 20–23, 1931	Birmingham, Ala.
American Society for Testing Materials	June 22–26, 1931	Chicago, Ill.
Assn. of Iron and Steel Electrical Engineers	June 15–19, 1931	Cleveland, Ohio
National Assn. of Mfrs. of Heating and Cooking Appliances	May, 1931	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 1–6	New York, N. Y.
National Glass Distributors Assn.	December 2–4	Pittsburgh, Pa.
National Paving Brick Mfrs. Assn.	February 4–6, 1931	Pittsburgh, Pa.
National Safety Council	Sept. 29–Oct. 4	Pittsburgh, Pa.
New Jersey Clay Workers Assn.	December	New Brunswick, N. J.
Scientific Apparatus Makers of America	May, 1931	Newport, R. I.
Taylor Society, Inc.	December 3–5	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	April 14–17, 1931	Milwaukee, Wis.
Western Canada Brick & Tile Assn.	December	Saskatoon, Sask.

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B

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Roessler & Hasslacher Chemical Co.

Borax Glass
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C

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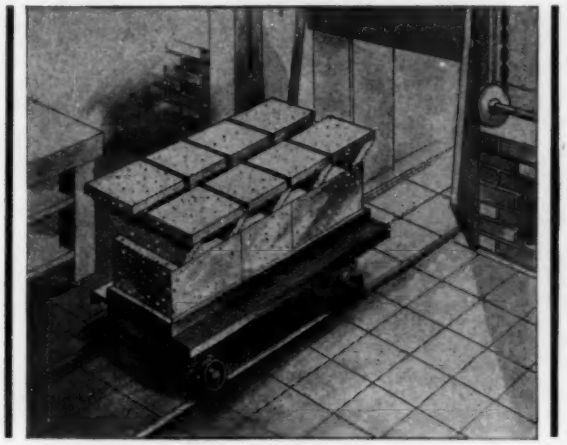

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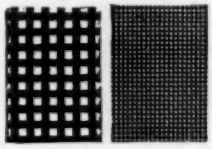

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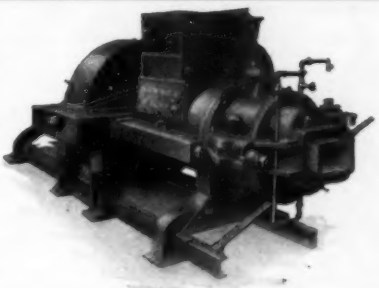

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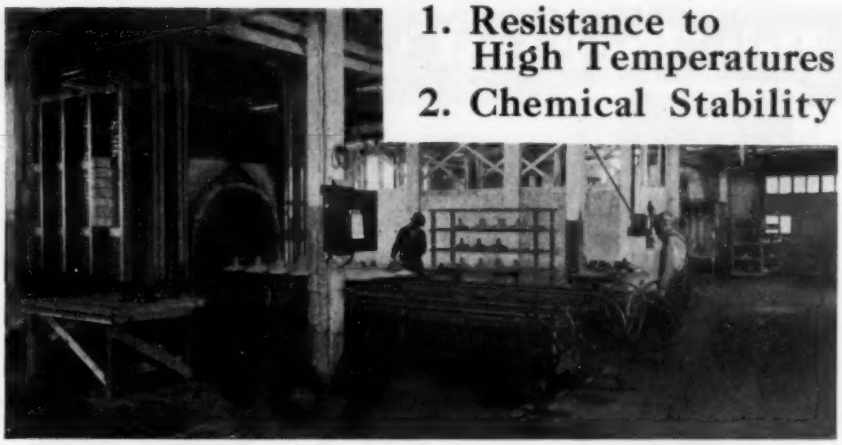

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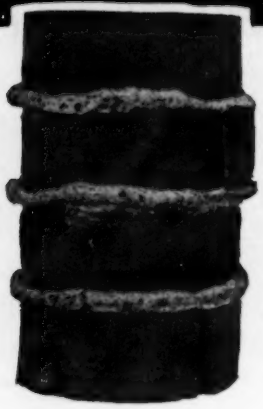
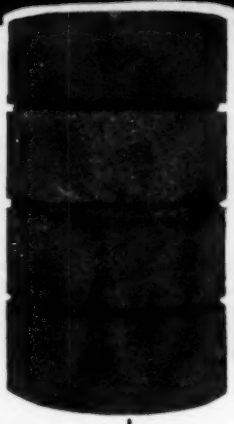
This "Pier Test" speaks for itself



This Pier *"failed"* at 2350° F.

—while—

This Pier was *"still good"* at 2700° F.



This Pier was laid with Joints of Fire Clay base Cement

These tests were conducted at the same time and under exactly the same conditions: Pressure 25 lbs. per sq. inch, and a temperature raise of 400° per hour.

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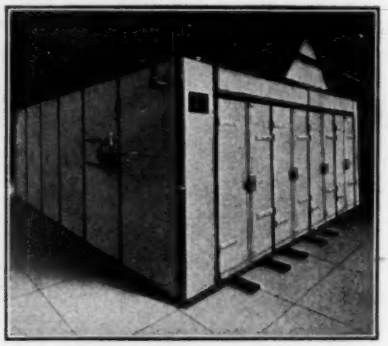

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